Agenda for HHS Public Health Activities (for Fiscal Years 2002–2007) at U.S. Department of Energy Sites

March 2002

U.S. Department of Energy
Office of Health Studies

and

U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry
Centers for Disease Control and Prevention
National Center for Environmental Health
National Institute for Occupational Safety and Health

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Introduction

The U.S. Department of Health and Human Services (HHS) and the U.S. Department of Energy (DOE), Office of Health Studies, developed the present *Agenda for HHS Public Health Activities (for Fiscal Years 2002–2007) at Department of Energy Sites*. HHS committees chartered under the Federal Advisory Committee Act provided suggestions on conducting HHS health studies and DOE public health activities at these sites: the Fernald Environmental Management Project, the Hanford Nuclear Reservation, the Idaho National Engineering and Environmental Laboratory, and the Savannah River Site. Open public meetings were specifically convened in 1997 and 1998 to gather suggestions and feedback on health studies and public health activities at the following DOE sites: the Los Alamos National Laboratory, the Oak Ridge Reservation, and the Rocky Flats Plant.

At public meetings at these and other DOE sites, individuals also provided input. A draft agenda was prepared and public comment sought. In April 1999, notice of the agenda was published in the *Federal Register* and 54 individuals or groups sent in comments. The present agenda reflects input from all the above-noted sources as well as comments received that are pertinent to the development of a consolidated and coordinated health studies and public health activities strategy for DOE workers and surrounding communities. DOE and HHS are examining ways to increase future public participation into the agenda process. One approach being used is to request comments when this agenda is distributed each year to the respective agencies' stakeholders and the public. Comments and suggestions received by the agencies are considered for incorporation into subsequent revisions of the agenda.

This agenda is not a complete review of the literature, but instead it provides some background for the proposed activities. It focuses primarily on current and future activities. Implementing the activities on the agenda is contingent on funding by Congress.

In the wake of the events following September 11, 2001, important resources including government staff and time were shuffled around the country. Proudly, many agencies offered their staff to assist in the sampling and cleanup involved at the World Trade Center in New York City, the Pentagon, and at anthrax-contaminated sites. The project timetables in this agenda were agreed upon before these events occurred. However, because of the services rendered by many government staff during our country's time of need, some timetables and projects completion targets initially presented in this agenda will need later revising.

The September 11, 2001, events are also likely to have many future ramifications throughout the government. It is difficult to determine how budget changes or presidential and congressional directives may alter the future of projects. Some resources and priorities may need to be temporarily diverted as the country tries to prepare and protect itself from terrorist activity.

Background

Energy-related health studies and public health activities conducted by the Centers for Disease Control and Prevention's National Center for Environmental Health (NCEH), the Centers for Disease Control and Prevention's National Institute for Occupational Safety and Health (NIOSH), and the Agency for Toxic Substances and Disease Registry (ATSDR) are accomplished under a Memorandum of Understanding (MOU) with HHS. DOE's Office of Environment, Safety and Health (EH) manages the MOU. A moratorium is currently in place on the destruction of any DOE records that might be useful in conducting health studies or public health activities.

Health-related research and public health activities are occurring at numerous sites. However, not all sites have ongoing or planned research or public health activities. Workers, managers, and other stakeholders have identified knowledge gaps that are both general to DOE and site-specific (including some sites not in this agenda.) This agenda attempts to address the identified gaps.

General Information and Overall Gaps in Knowledge

Scientific opinions regarding the magnitude of risk associated with chronic low-level radiation exposure are polarized and the subject of ongoing debates. The contribution of risks to workers and community members around DOE sites stemming from exposures to chemical hazards and combinations of chemicals and radioactive materials have not been adequately described. For the reasons listed below, the next decade is the best time to study low-level radiation exposure, and any association of chemical and complex chemical/radiological exposures among workers and community members around DOE sites.

- Findings may be relevant to former workers, to 300,000 current DOE nuclear-facility workers, to the 1.5 million current U.S. radiation workers in other industries (including nuclear energy and the medical field), and to community members around DOE sites,

- Findings may help resolve the controversy surrounding low-level chronic exposure and linear no-threshold risk models,

- Findings would address and answer concerns and interests of stakeholders about the risks from chemicals and the combination of chemical/radioactive hazard exposures,

- An important window of opportunity of limited duration for DOE records and institutional memory of past and present employees currently exists, and

- Latency periods for the development of health effects in workers and communities are long enough (in most cases) to conduct meaningful health studies.

Nevertheless, no single study will remove all uncertainty from the current risk estimates. The exact relationship between adverse health effects and exposures to chemicals or radioactive materials can only be discovered and appropriately characterized through the collective evaluation of multiple epidemiological and mechanistic studies. For example, recent occupational studies found a dose-response relationship between external radiation dose and the risk of mortality from lung cancer (Fernald) and leukemia (Savannah River). Also, the recent multi-national study by the International Agency for Research on Cancer (IARC) showed a dose-response relationship for external radiation and leukemia.

The following general activities have knowledge gaps that need to be addressed (this list is neither final nor comprehensive).

- Further epidemiologic research is needed to evaluate current occupational radiation exposure limits. Many of these exposure limits were developed from bomb survivor and radiation therapy exposure data that differ in intensity, duration, route of exposure, and frequency from that found in the workplace.

- The relationship between internal radiation dose and health effects needs to be evaluated.

- Results from ongoing mortality studies need to be evaluated to improve our understanding of the causes of cancer and chronic diseases. Additional studies can be proposed to focus on a single disease in worker groups, such as previously reported excesses of multiple myeloma and Hodgkin disease.

- Complete records, including industrial hygiene and work history data for the various levels of subcontractors at each site, must be made available.

- Primary care providers should be given lists of sentinel health events for radiation communities and training programs.

- As significant exposures are identified, community members and healthcare professionals need educational information concerning risks and potential health effects.

- Subcontractors and cleanup workers, as well as their respective exposures, need better characterization and documentation.

- Health effects among workers with simultaneous exposures to low levels of chemicals and/or radiation and other risk factors should be addressed.

- Emerging findings from DOE funded former worker medical monitoring projects suggest that nonradiological hazards may contribute to work-related disease among DOE workers to a greater extent than previously recognized.

Agenda Organization

The agenda is organized first according to general information and overall gaps in knowledge about the health effects of hazards at DOE sites and then alphabetically by the DOE site for which specific public health activities and/or research are planned. The NIOSH Multi-Site Section describes single and/or multi-site worker studies proposed by NIOSH, but for which sites cannot be selected until additional evaluation is carried out to determine the best locations for conducting the studies. Other sections describe multi-site studies performed by ATSDR, NCEH, and DOE. The following information is provided for each site plan:

- Background information on the site
- Summary of past studies and assessments of the site
- Summary of current health research and public health activities at the site
- Issues that might need to be addressed in the future about the site
- Ongoing and proposed new activities at the site for FY 2002–2007

Brookhaven National Laboratory (BNL)

Upton, New York

Background

The Brookhaven National Laboratory (BNL) consists of slightly more than 8 square miles (5,265 acres) near the center of Long Island, in Suffolk County, about 60 miles east of New York City. The surrounding area is heavily populated, with more than 1.5 million people living in Suffolk County.

BNL is an active site, which carries out basic and applied research in high-energy nuclear and solid state physics; fundamental material and structure properties and the interactions of matter; nuclear medicine; biological effects of ionizing radiation; medical uses of radionuclides and ionizing radiation; biomedical and environmental sciences; and selected energy technologies. The Army used the site (named Camp Upton) during World Wars I and II. From 1947 to 1998, Associated Universities, Inc., operated BNL under contract first to the Atomic Energy Commission and then to the Department of Energy (DOE). Brookhaven Science Associates now operates BNL under contract to DOE.

Past practices at BNL have resulted in on and off-site groundwater contamination with radionuclides, such as tritium and strontium-90. A 1992 Interagency Agreement signed by the Environmental Protection Agency, the New York State Department of Environmental Conservation, and DOE governs the environmental restoration program. Suffolk County and the public are active in the decision-making process. The site is removing or immobilizing sources of groundwater contamination, and treating groundwater to remove contaminants.

The community is concerned about groundwater contamination, the existence of radionuclides in on-site soils, off-site contamination in the Peconic River, and the effects of radioactive air emissions resulting from past and present facility operations. The community and special interest groups are highly aware of activities at the site since a tritium leak from the spent fuel pool of one of the two research reactors was discovered. The community is especially concerned about the association between an increased incidence of cancer, especially breast cancer on Long Island, and air releases of radionuclides from the site's reactors.

Past Activities at BNL

Off-Site Contamination

- A health consultation by the Agency for Toxic Substances and Disease Registry (ATSDR), which focused on groundwater, concluded that sampling results of residential wells do not indicate that individuals are being exposed to contaminant levels that

would cause adverse health effects. In 1995, plumes of groundwater contaminated with volatile organic compounds (VOCs), including carbon tetrachloride, were found off-site. Further characterization found that the contamination had migrated approximately 7,500 feet south of the site boundary. The plumes become deeper as the distance from the source areas increases. Contaminants are generally deeper than residential wells in the area. A plume of lower concentration VOCs, predominantly trichloroethylene, extends approximately 4,000 feet east of the site boundary. The source of the contaminants is historical releases from the BNL sewage treatment plant. While low levels of tritium have been detected off-site, no monitoring well or residential well samples are above the drinking water standard for any radionuclide.

➢ As a precaution, DOE offered to test the water in existing private wells that might be affected and, at the homeowner's option, connect residences to the public water supply. When the hookup program ended in 1998, DOE, in conjunction with the Suffolk County Department of Health Services, had connected approximately 1,500 residences to the public water supply.

Community Health Studies and Activities

➢ A 1994 study by the New York State Department of Health (NYSDH) found elevated risks for postmenopausal breast cancer among women living close to chemical facilities in Nassau County. Although BNL is not located in this county, community and activist groups are concerned about BNL's possible contribution to increased incidences of breast cancer.

➢ A limited study commissioned by the Suffolk County legislature assessed the geographic patterns of cancers and congenital malformations in relation to BNL. Cancer rates for all types of cancers studied, including childhood cancers, were not elevated near BNL, and there was no evidence that rates differed by sector or were correlated with underground plume or wind direction. Malformation rates were similar in Suffolk County and other areas, except for congenital hip dislocation, which was higher in Suffolk County but similar to the rate of upstate New York. The rate of female breast cancer was elevated on the east end of Long Island, however, it was not attributed to BNL.

Studies of the Health of BNL Workers

The NYSDH recently released a study comparing the cancer incidence of workers at BNL to other the cancer incidence in New York stateless New York City and Suffolk County.

Current Activities at BNL

Community Involvement

ATSDR meetings to determine priorities for public health assessment and consultation. As part of the public health assessment process, ATSDR, DOE, and local community members and organizations (e.g., homeowners' associations from the Yaphank, Manorsville, Longwood, Brookhaven, and Middle Island communities; and two activist groups: the Citizens Campaign for the Environment and Environmental Advocates of Long Island) are determining priorities. The community has requested health consultations on groundwater contamination and air quality. ATSDR has completed the groundwater health consultation and presented its findings to the Brookhaven Executive Roundtable.

Off-Site Contamination

ATSDR public health assessment. ATSDR is preparing a public health assessment of the public health impact from releases of hazardous materials from the site. Potential exposure pathways include on- and off-site groundwater contaminated with VOCs, and on-site groundwater contaminated with radionuclides. Air releases are also being considered. In addition, community health concerns, such as incidence of rhabdomyosarcoma and health outcome data for the area, are being evaluated.

Community Health Studies and Activities

- **ATSDR health education and promotion.** As a followup to the public health activities conducted at the site, ATSDR will provide health education and health promotion activities for the communities around the site. This could include healthcare provider education and community education regarding the information from the state health department and other agencies' work.

- **Long Island Breast Cancer Study Project.** This multi-study effort investigates whether environmental factors are responsible for breast cancer in Tolland County, Connecticut, and in the New York counties of Nassau, Schoharie, and Suffolk. The study began in 1993 and is funded and coordinated by the National Cancer Institute and the National Institute for Environmental Health Sciences.

DOE Epidemiologic Surveillance of Current Workers

DOE's epidemiologic surveillance assesses the overall health of the *current* DOE work force at 14 DOE sites, including BNL. The goal is to identify groups of workers who are not always union workers that may be at increased risk for occupation-related injury and illness.

DOE Former Worker Surveillance Program

DOE, in conjunction with the New York State Cancer Registry, is assessing the distribution of cancer among workers.

Issues Needing Attention at BNL

- Community groups have requested an in-depth epidemiologic study of workers.
- The community is concerned about rhabdomyosarcoma in relationship to BNL.

Proposed Activities at BNL

Ongoing Activities

The agencies propose to continue the previously listed projects already underway and to initiate new ones. However, such activities will be implemented only if feasible and appropriate and beneficial to the community. The agencies will establish a coordinated plan, schedule, and lead organization for each new public health activity. The plan and schedule will be presented to all potential partners for their comment.

New Activities for FY 2002–2007

- **ATSDR health studies**. Future health studies will be determined based on the findings of the public health assessment.
- **NIOSH Occupational Health Studies (2002) Walk-through Survey — Brookhaven.** The Centers for Disease Control and Prevention's National Institute for Occupational Safety and Health (NIOSH) plans to conduct a walk-through survey of Brookhaven in 2002, and to assess records and other information to determine the feasibility and necessity of future worker studies.

Energy Technology Engineering Center (Santa Susana Field Laboratory, SSFL)

Simi Valley, California

Background

The 2,700-acre Santa Susana Field Laboratory (SSFL) is located in Simi Valley, Ventura County, California. SSFL was established in 1946 to test rocket engines. The then named Atomics International facility was operated by North American Aviation. Later name and ownership changes resulted in current operations of the site by Rocketdyne, until recently a division of Rockwell International. Rocketdyne is now a division of Boeing North American.

The Department of Energy (DOE) lease-options a small part of Area IV, known as the Energy Technology Engineering Center (ETEC), which consists of government-owned buildings on 90 acres of land owned by Rocketdyne. The ETEC site includes buildings used for auxiliary support facilities mechanical and chemical test facilities; offices; and the testing of apparatus for large-scale heat transfer and fluid mechanics experiments. ETEC opened in the late 1950s and developed security-sensitive projects involving hazardous materials. These projects supported nuclear research and energy development projects for DOE and its predecessor agency. There are no longer any DOE-funded research and development activities at the site.

Past Activities at SSFL

Off-Site Contamination

- The site has a number of buildings and areas contaminated with chemical and radioactive substances. This contamination may exist in the air, groundwater, soil, structures, and surface water. Some testing procedures and the sodium disposal facility are the source of some off-site contamination, including contamination with tritium and other radionuclides. Off-site radionuclides that exceed background concentrations include cesium-137, plutonium-238, strontium-90, and tritium.

- **ATSDR preliminary site evaluation.** In December 1999, ATSDR completed a Draft Preliminary Site Evaluation for SSFL, which concluded that a more in-depth evaluation of exposure pathways that addresses past, current, and future exposure to chemicals and radionuclides from SSFL is needed.

Community Health Studies and Activities

- The California Department of Health Services conducted a cancer incidence study in the Los Angeles County census tracts near SSFL for 1978–1989. The study found that, for

1983–1988, males residing near SSFL were at increased risk of developing cancers, in particular bladder cancer, possibly due to radiation.

➢ In 1997, the Tri-Counties Regional Cancer Registry performed a preliminary analysis on 1988–1995 cancer incidences among Ventura County residents living within a 5-mile radius of SSFL. An increase in lung cancer was reported for the combination of men and women. However, this increase was small, and lung cancer was not significantly increased in men or women separately. This preliminary analysis also reported a significant decrease in the leukemia incidence in women.

➢ As part of DOE funding, which ended in FY 1999, the State of California established an oversight panel of citizens and scientists to study Rocketdyne workers. The panel has recommended that a community health study be conducted.

Studies of the Health of SSFL/ETEC Workers

The University of California at Los Angeles (UCLA) conducted two epidemiologic studies of workers employed at Rocketdyne/Atomics International in Ventura County. Many of these workers were assigned to SSFL. The first study was of mortality among workers monitored for exposure to ionizing radiation. The second study was an in-depth analysis of mortality among workers exposed to asbestos and the rocket fuel monomethyl hydrazine.

➢ The first study concluded that workers exposed to higher lifetime doses of external ionizing radiation had an increased risk of dying from cancers of the blood and lymphatic system, and from lung cancer. Among workers who were monitored for internal radiation, those who received higher lifetime doses had a significantly higher risk of dying from cancers of the blood and lymphatic system and cancers of the esophagus, oral cavity, pharynx, and stomach.

➢ In the second study, asbestos and hydrazine exposures were evaluated for radiation-monitored workers. The study concluded that the higher risk of lung cancer seen for these workers was not due to asbestos exposure. Workers exposed to the highest levels of hydrazine in the 1960s had a higher risk of lung cancer relative to those with the lowest exposures.

Current Activities at SSFL

Off-Site Contamination

The California Department of Toxic Substances Control (DTSC) has indicated that off-site contamination studies may be required as part of the Resource Conservation and Recovery Act Facility Investigation for the site. In addition, at the last meeting of the SSFL Work Group,

the Environmental Protection Agency and DTSC stated that they would consider additional off-site sampling.

Community Health Studies and Activities

In response to petition requests from Senators Diane Feinstein and Barbara Boxer, and Representative Elton Gallegly, ATSDR released a draft preliminary site evaluation in December 1999. The document addressed the concerns of the community and presented a preliminary assessment of the potential for adverse human health effects from past, present, and future activities at the site based on currently available information. The preliminary site evaluation recommended specific follow-up activities.

Occupational Health Studies

No occupational health studies are currently underway.

Issues Needing Attention at SSFL

A more in-depth evaluation of exposure pathways that addresses past, current, and future exposure to chemicals and radionuclides from SSFL exists. The assessment should address the following issues:

- The development of a regional hydrogeological flow model and additional monitoring at down-gradient springs or seeps in Simi Valley and Santa Susana Knolls to evaluate the potential for deep fracture flow and future exposure,

- The additional radiological characterization of Area IV with more sensitive instrumentation and appropriate grid spacing to ensure a lower detection limit,

- A more in-depth evaluation of airborne chemical releases from SSFL operations, including air dispersion modeling of past accidents and disposal activities, and the compilation and use of a consistent, site-specific meteorological data set to improve the assessment of past exposures to these substances, and

- A re-analysis of the cancer registry data, which includes additional years of newly available cancer data and updated demographic information, to determine if the apparent increases in the incidence rates of bladder and lung cancers persist.

Proposed Activities at SSFL

New Activities for FY 2002–2007

➢ **ATSDR exposure assessment and ATSDR health education and promotion**. In December 1999, ATSDR completed a Draft Preliminary Site Evaluation for SSFL. ATSDR will coordinate a public health action plan to provide a more in-depth evaluation of exposure pathways that will address the gaps identified in the preliminary site evaluation. ATSDR contracted Eastern Research Group, Inc. (ERG) to conduct the Santa Susanna Health Initiative. This initiative will encompass the following tasks:

- A more in-depth evaluation of exposure pathways that addresses past, current, and potential future exposure to chemicals and radionuclides from SSFL to determine the potential for off-site exposures and any public health implications associated with the site,

- An analysis of all relevant cancer registry data currently available to determine whether elevated cancer rates exist in the communities around the site, and

- Community outreach and education activities to ensure that community members are aware of and understand these activities and know that their concerns are addressed.

➢ **ATSDR meetings**. Because a local presence is desirable, ERG has sub-contracted theses tasks to the schools of Public Health and Engineering at UCLA. The project is expected to take 3 years to complete.

Fernald Environmental Management Project (FEMP)
Fernald, Ohio

Background

The Feed Materials Production Center (FMPC) was a Department of Energy (DOE) facility located near Fernald, Ohio, about 18 miles northwest of Cincinnati. FMPC was operational from 1951 to 1988, and was involved in a number of activities related to uranium production and processing. Specifically, the facility produced highly purified uranium metal products that were used as feed materials in DOE production reactors. After production stopped, the site was renamed the Fernald Environmental Management Project (FEMP). DOE and its contractor are now decommissioning and cleaning up the site.

During its more than 40 years of operation, the facility released radioactive and hazardous materials into the environment, primarily uranium, radon, and radon decay products. Releases occurred during routine plant operations and waste management and storage activities. Four large concrete silos, built in 1952, store radioactive residues from former uranium processing activities. Two of these, the K-65 silos, contain high radium-bearing residues. The silo residues are being removed, processed, and shipped off-site for permanent disposal sometime after 2007.

Emissions from the K-65 silos have been a significant source of radon exposure to workers and residents. In 1991, bentonite clay was injected into the silos to cap the residues and reduce radon emissions. Communities and workers have health concerns about the radioactive wastes stored at the site and the historical releases to the environment.

Past Activities at FEMP

Off-Site Contamination

- **NCEH Fernald Dosimetry Reconstruction Project.** Studies by the Centers for Disease Control and Prevention's National Center for Environmental Health (NCEH) have shown that past inhalation of radon and radon progeny from the silos (prior to capping with bentonite) was a major contributor to radiation dose. Other contributors included uranium, thorium, and other radionuclides. The project estimated releases of radiation materials from past operations at the Fernald site and the potential effects of those releases on off-site residents.

- **NCEH Fernald Risk Assessment Project.** This project aims to characterize the human health risk that may be associated with past exposures to radioactive materials that were released from FMPC while it was operating. The project seeks to address community health concerns and to help evaluate the feasibility of an epidemiologic study within the

community. The first phase of this project provided estimates on the impact of the site on lung cancer mortality. The study reported that the estimated number of lung cancer deaths occurring between 1951 and 2088 may increase between 1% and 12% as a result of FMPC radiation exposure. Exposure to radon and radon progeny accounted for most of the estimated total lung dose. Estimates are projected through the year 2088 to allow residents who were exposed the last year the plant operated, 1988, to reach 100 years of age.

The second phase of this project provided screening level estimates of the lifetime risk for developing kidney cancer, female breast cancer, bone cancer, and leukemia as a result of the maximum estimated exposure to radioactive materials released from the site.

The project estimated an upper bound (or worst case number) of 23 or less additional cases of leukemia, 4 or less additional cases of kidney cancer, 3 or less additional cases of female breast cancer, and 4 or less additional cases of bone cancer among the approximately 46,000 people who resided within the assessment domain sometime from 1951 through 1988 as a result of exposure to radiation released from the site.

➢ **ATSDR public health assessment.** In May 2000, ATSDR released a public health assessment for public comment. ATSDR concluded that past exposure to uranium in groundwater was a public health hazard. (NCEH had previously determined that past airborne exposure to radon had been a public health hazard.) Although potential effects from current exposure to groundwater could not be determined because of incomplete information, ATSDR concluded that there are no known exposure pathways that now pose a public health hazard under current conditions at the site.

➢ **ATSDR residential radon monitoring.** Public concern about whether bentonite caps on the K-65 silos effectively controlled radon emissions led ATSDR and the Environmental Protection Agency's (EPA) National Air and Radiation Environmental Laboratory (NAREL) to monitor radon levels in residences near the site. Two sets of indoor radon measurements were made from 1993 to 1994. The radon levels measured in most homes were below the EPA's recommended action level of 4 picocuries per liter (pCi/L). Therefore, they were considered typical of naturally occurring radon and not indicative of increased radon emissions from the site. ATSDR notified residents of homes with radon levels greater than 4 pCi/L and provided information about radon sources and abatement.

➢ **ATSDR ambient radon monitoring.** In response to public concern about radon releases from the K-65 silos and other sources on the site, ATSDR and NAREL have been monitoring radon levels in ambient air off-site since 1993. ATSDR concluded that, despite increases in on-site radon emissions over time, radon measured in off-site air has been relatively constant and at levels considered typical of naturally occurring radon. An ATSDR health consultation summarizes the findings of radon monitoring from

December 1993 to June 1994. ATSDR is continuing the ambient radon monitoring during the remediation process.

➢ **ATSDR health consultation on local milk.** ATSDR concluded that levels of radionuclides in locally produced milk are not a public health hazard.

➢ **ATSDR health consultation on local produce.** ATSDR concluded that levels of radionuclides associated with locally grown produce are not a public health hazard.

➢ **ATSDR health consultation on groundwater.** ATSDR concluded that using groundwater for non-drinking water uses is not a health hazard from radionuclides.

Community Health Studies and Activities

➢ In November 1998 and February 2000, ATSDR provided health education for Fernald area healthcare professionals. The program provided information and education about industrial processes at Fernald; historical and current radiological and chemical exposures to workers and residents; the results of Centers for Disease Control and Prevention's National Center for Environmental Health's (NCEH) lung cancer risk assessment; and resources for healthcare providers. Representatives from the University of Cincinnati, Mercy Health Partners, the Fernald Health Effects Subcommittee, the Centers for Disease Control and Prevention's National Institute for Occupational Safety and Health (NIOSH), and ATSDR participated in the program.

➢ **Fernald Health Effects Subcommittee (FHES).** The FHES was chartered in 1996 by NCEH, NIOSH, and ATSDR to seek stakeholder input into health-related activities for the site. The subcommittee provided advice and guidance on Fernald-related research and public health activities of the agencies. The FHES advised CDC and ATSDR on their health research and proposed actions based on each agency's findings. The FHES held its final meeting on August 22, 2001, in Harrison, Ohio. NCEH has no plans for additional work at Fernald; ATSDR is nearing completion of its Public Health Assessment at the site, and NIOSH will continue its approach of meeting independently with workers to obtain input and may convene public meetings as the need arises, rather than through the Federal Advisory Committee Act process. CDC and ATSDR will continue to solicit Fernald community representation on any future national advisory committees and may, on occasion, conduct ad hoc meetings in the community based on relevant new developments. FHES was an exemplary committee that has provided the federal agencies with important and timely advice.

➢ **ATSDR examination of medical monitoring data.** ATSDR sponsored the University of Cincinnati Medical Center to conduct a study on the prevalence of noncancer adverse health outcomes in persons living near the site. The university used previously collected (since 1990) physical examination and questionnaire data from participants of the

Fernald Medical Monitoring Program (FMMP). Researchers analyzed medical and residential history, demographic variables, and selected diagnostic tests (hematology, serum chemistry, and urinalysis). The final report was published in FY 2001.

Studies of the Health of Fernald Workers

- The mortality of 4,014 white male workers hired at Fernald from 1951 to 1981 was studied. Hourly workers had higher death rates than the general population for combined cancers, lung cancer, and motor vehicle accidents. Salaried workers had a higher rate of death from stomach cancer. Lung cancer death rates increased as radiation dose increased, and noncancerous respiratory disease mortality increased with internal radiation dose.

- A multi-site study of lung cancer mortality and uranium dust exposure at four uranium processing operations included 51 Fernald workers. However, specific results for Fernald were not reported. Overall, a higher risk of lung cancer was reported for workers first hired at age 45 years and older.

- **Mortality Among Female Nuclear Workers (MAFN).** A study of female workers from 12 DOE plants, including Fernald, was combined in a cohort mortality study, and risk estimates were developed for exposure to ionizing radiation or to chemical hazards. For the entire pooled cohort, mortality from mental disorders, diseases of the genitourinary system, and from ill-defined conditions was higher than expected. External ionizing radiation exposure in these workers appeared to be associated with increased relative risk for leukemia and, to a lesser degree, with increased relative risks for all cancers combined and for breast cancer.

- **Decontamination and Decommissioning Workers Registry (DDWR).** A NIOSH study assessed whether the information and records at seven DOE sites, including Fernald, accurately identify remediation workers and their complete exposure, work history, and medical information. Because this information is not available, individual workers cannot consistently be linked to their exposure and medical data, and comprehensive epidemiologic, exposure assessment, or hazard surveillance studies of remediation workers cannot be conducted.

- **Exposure Assessment of Hazardous Waste, Decontamination and Decommissioning, Cleanup Workers (HAWW).** Feasibility studies at seven DOE sites, including Fernald, determined that the availability of records to identify workers and their primary activities, exposures, work histories, and medical information varied significantly from site to site. The necessary information to conduct exposure assessment, hazard surveillance, or epidemiology studies of remediation workers is currently not readily available. Within sites, data systems are fragmented and data management is inconsistent in the current environment of decentralized management and increased subcontracting.

Current Activities at FEMP

Off-Site Contamination

- **ATSDR consultation on catastrophic events.** In response to community concerns about potential exposures from the K-65 silos, ATSDR is preparing a health consultation to address catastrophic events.

- **ATSDR monitoring of radon in ambient air.** ATSDR plans to continue monitoring radon in ambient air near the site during the remediation process.

Community Health Studies and Activities

- **ATSDR health education and promotion.** In November 1998 and February 2000, ATSDR completed healthcare provider training programs. Future training programs will be developed as needed, pending the completion of additional studies and assessments being conducted by ATSDR, NCEH, and NIOSH.

NIOSH Occupational Health Studies

- **Mortality/Exposure Assessment Study of Fernald (FNUP).** NIOSH is updating and expanding the mortality study of Fernald workers to expand on the studies of white males hired at Fernald from 1951 to 1981. All workers, including females and nonwhite workers employed from 1951 to 1989, will be examined. Special attention will be paid to worker exposures to acid mists, asbestos, radon, and uranium dust.

- **Radon and Cigarette Smoking Exposure Assessment in Fernald Workers (PFRS).** University of Cincinnati researchers are developing yearly and cumulative individual radon exposure estimates for Fernald workers using data from existing occupational histories and other site information. Smoking history information from an ongoing medical surveillance program will be extended to living workers not enrolled. Surrogate data will be collected from family members of the deceased. Risk estimates for lung cancer will then be calculated for the Fernald workers.

DOE Epidemiologic Surveillance of Current Workers

DOE's epidemiologic surveillance assesses the overall health of the *current* DOE work force at 14 DOE sites, including FEMP. The goal is to identify groups of workers that may be at increased risk for occupation-related injury and illness.

Issues Needing Attention at FEMP

To address community concerns about the storage of radon in the K-65 silos, potential exposures to radionuclides must be evaluated if a catastrophic event (for example, an earthquake or tornado) occurs and disrupts the integrity of the silos.

Proposed Activities at FEMP

Ongoing Activities

The agencies propose to continue the previously listed projects already underway. New activities will be initiated only if feasible and deemed appropriate and beneficial to the community. The agencies will establish a coordinated plan, schedule, and lead organization for each new public health activity. The plan and schedule will be presented to all potential partners for their comment.

New Activities for FY 2002–2007

- **ATSDR health studies.** Potential environmental impacts include releases of uranium into the air, water, and soils in the area surrounding the plant. Medical surveillance of citizens in this area is now being conducted through the Fernald Resident Medical Monitoring Program. Funding is being requested for an updated analysis of clinical laboratory tests and selected outcomes, such as cancers, on this population for the years up to 2002. In addition, because of the potential effects of uranium on the urinary tract, an analysis of end stage renal disease for the Fernald population is also being proposed.

- **ATSDR health education and promotion.** ATSDR, in coordination with the University of Cincinnati, will develop a Grand Rounds presentation in FY 2002. The Grand Rounds presentation will provide physicians with information on three important studies: ATSDR's Public Health Assessment; ATSDR's study of non-cancerous health effects in the residential population; and the University of Cincinnati's study on spatial analysis of urinary system cancer.

Hanford Nuclear Reservation
Richland, Washington

Background

The 570-square mile Hanford Nuclear Reservation is located in southeastern Washington State near the cities of Richland, Pasco, and Kennewick. Starting in 1944, Hanford produced plutonium. During the early years of operation, large amounts of radioactive materials were released into the atmosphere and the Columbia River, including an estimated 740,000 curies of Iodine-131 (I-131) into the atmosphere and 22 million curies of mixtures of radionuclides into the Columbia River.

Radioactive materials, such as plutonium, have been inhaled or ingested by workers, but the extent of this form of radiation exposures is uncertain. In addition, approximately 30 million cubic feet of high-level, transuranic, low-level, and tank wastes are stored on-site. Communities, tribal nations, and workers are concerned about the health hazards posed by the hazardous wastes stored on-site and the historical releases to the air and water.

Past Activities at the Hanford Nuclear Reservation

Off-Site Contamination

- **Hanford Environmental Dose Reconstruction (HEDR).** This project evaluated historical off-site radioactive releases from Hanford to the surrounding communities. The study indicated that the largest doses of radiation to residents surrounding the site were from I-131 released to air and deposited on soil and into the Columbia River between December 1944 and December 1957. The most important radiation exposure pathway for I-131 was the consumption of contaminated milk produced by cows and goats that the residents kept on their properties. Children received the highest estimated thyroid doses. Radiation doses from releases to the Columbia River were highest from 1956 through 1965, peaking in 1960. The most important exposure pathway was the consumption of nonmigratory fish from the Columbia River during the years of releases, a particular concern to Native Americans.

- **ATSDR public health assessment for the Hanford 1100 Area (the vehicle maintenance area).** ATSDR concluded that the area did not pose a public health hazard from site-specific contaminants and that follow-up health actions are not indicated at this time.

- **ATSDR health consultation for the North Slope Area.** ATSDR concluded that data were inadequate to determine if there was a threat to human health if the area were used

as a wildlife refuge or if use were unrestricted, which would include agricultural and residential development.

➢ **SENES Oak Ridge, Inc., analysis.** This ATSDR-sponsored analysis concerned dose estimates from eating contaminated fish and waterfowl along the Columbia River during the period of peak releases. The analysis found that additional work was needed before doses could be calculated for Native American dietary lifestyles. Specifically, the report recommended that three other radionuclides be considered: (1) I-131 because children are more sensitive, (2) cobalt-60 because it accumulates in soil and sediment, and (3) strontium-90 (Sr-90) because it accumulates in fish bones. Assuming people only ate filleted fish did not account for all of the Sr-90 exposure if they ate the whole fish.

Community Health Studies and Activities

➢ **The ATSDR Infant Mortality and Fetal Death Analysis.** This study, finalized in November 2000, investigated the association between estimated I-131 exposure and infant mortality, fetal death, and preterm birth. The study focused on the years 1940–1952, and included the eight Washington counties in the HEDR project (Adams, Benton, Franklin, Grant, Kittitas, Klickitat, Walla Walla, and Yakima). The study used the HEDR project's 1945 exposure estimates for I-131, and found a 70% higher rate of preterm birth and a 30% higher rate of infant mortality in the areas with the highest estimates of I-131 exposures compared to areas with the lowest estimates of exposure. No association was found for fetal death.

➢ **NCEH Hanford Individual Dose Assessment (IDA) project.** This project provided individual thyroid dose estimates to people who lived or spent time in the HEDR study area and helped them understand what it means to their health. Approximately 8,000 dose estimates were provided to people who lived in the study area between December 26, 1944, and December 31, 1957, and who were therefore potentially exposed to air releases of I-131. This project was a service, not a study, and was provided through a joint effort of the state health agencies in Idaho, Oregon, and Washington.

➢ **Hanford Health Information Network (HHIN).** HHIN was a partnership among the state health agencies of Idaho, Oregon, Washington, and nine Pacific Northwest Indian Nations. HHIN prepared and distributed information about the releases of radioactive materials from the site and what was known about the potential health effects of radiation exposure. HHIN built a credible communication program, focusing on a two-way, interactive exchange of information with individuals and groups about health effects and concerns they may have. HHIN provided information to citizens and education to healthcare providers about Hanford releases, health risks, and related topics. Information was provided from a variety of perspectives allowing individuals to draw their own conclusions. HHIN was established by Congress in 1991 and funded by the U.S. Department of Energy until June 2000.

Studies of the Health of Hanford WorkersJ50

Workers at Hanford have been included in previous epidemiologic studies. Findings include the following.

- Positive trends in the death rate with occupational exposure to external ionizing radiation have been reported for liver cancer, cancer of the pancreas, female genital cancer, multiple myeloma, and Hodgkin disease.

- Lung cancer has been associated with internal radiation exposure in populations such as uranium miners but there is less certainty about any relationship with external exposure.

- In a recent multi-site study sponsored by the Centers for Disease Control and Prevention's National Institute for Occupational Safety and Health (NIOSH), an age at exposure effect was found. External doses received at older ages, particularly over 45 years, were associated with an increased risk of multiple myeloma.

- A study of the potential association between paternal exposure to ionizing radiation at Hanford and risk of childhood cancer found no evidence of a link between leukemia and paternal employment at Hanford and weak evidence for a link with central nervous system cancer.

- Beryllium metal was machined at Hanford and some of the workers exposed to the metal have chronic beryllium disease.

- **Mortality among Female Nuclear Workers (MAFN).** A study of female workers from 12 Department of Energy (DOE) plants, including Hanford, was combined in a cohort mortality study, and risk estimates were developed for exposure to ionizing radiation or to chemical hazards. For the entire pooled cohort, mortality from mental disorders, diseases of the genitourinary system, and from ill-defined conditions was higher than expected. External ionizing radiation exposure in these workers appeared to be associated with increased relative risk for leukemia and, to a lesser degree, associated with increased relative risks for all cancers combined and for breast cancer.

- **Exposure Assessment of Hazardous Waste, Decontamination and Decommissioning, Cleanup Workers (HAWW).** Feasibility studies at seven DOE sites, including Hanford, determined that the availability of records to identify workers and their primary activities, exposures, work histories, and medical information varied significantly from site to site. The necessary information to conduct exposure assessment, hazard surveillance, or epidemiology studies of remediation workers is currently not readily available. Within sites, data systems are fragmented and data management is inconsistent in the current environment of decentralized management and increased subcontracting.

Current Activities at the Hanford Nuclear Reservation

Community Involvement

- **Hanford Health Effects Subcommittee (HHES).** ATSDR and the Centers for Disease Control and Prevention implemented a community involvement activity with the formation of the HHES in January 1995. The subcommittee, which includes technical experts, clinicians, citizens, public interest groups, tribal representatives, labor representatives, and governmental liaisons (tribes and health departments), provides advice and guidance to Hanford-related research and public health activities of the agencies.

- **ATSDR tribal grants.** The nine tribes use tribal cooperative agreements funded by ATSDR (in FY 1999 and 2000) to address human health issues related to exposures from Hanford releases and to build tribal capacity in collaboration with ATSDR on site-specific public health activities, community involvement, and preventive health education.

  Through funding from ATSDR, the Inter-tribal Council on Hanford Health Projects provides advice and guidance to the agencies from the perspective of the nine Native American tribes within the Hanford region.

Off-Site Contamination

- **ATSDR public health assessment.** ATSDR is conducting a combined public health assessment of the site (the 100, 200, and 300 Areas) and is working with HHES to revise the public health assessment document. The agency also performs health consultations on site-specific issues.

- **NCEH Columbia River dose reconstruction followup.** NCEH is funding a contract to complete additional work on the Columbia River dose reconstruction model. Once completed, Native Americans and others whose diets included fish from the Columbia River between 1956 and 1965 will benefit from new parameters to estimate radiation doses. The model will include the 11 radionuclides for which HEDR had source term estimates, plus cobalt and strontium for which HEDR did not have source term estimates.

➢ **NCEH followup to hot particles report.** NCEH is developing computer programs to calculate the evaluation of radioactive particles and short-lived radionuclides doses to persons, such as members of the armed services and construction workers, whose duty locations and/or living quarters were within the bounds of the reservation. Estimates of doses for persons in off-site locations can also be performed using the code.

➢ **ATSDR Columbia River assessment for possible medical monitoring.** ATSDR plans to implement a Columbia River Assessment to be conducted in parallel with the NCEH dose reconstruction activity for the river. This would provide dose estimates for people who ate fish from the Columbia River which were contaminated from releases from the Hanford reactors. A series of workshops will be conducted with experts and community and tribal representatives to evaluate the exposures and potential human health risks.

➢ **NCEH Web-based IDA project.** NCEH is developing a Hanford Individual Dose Assessment (IDA) tool to allow individuals to estimate their personal thyroid dose as a result of exposure to historic I-131 releases from the site. Only a minimum amount of user-supplied information will be required to perform this calculation. This tool will be accessible on the Internet.

➢ **ATSDR Hanford Community Health Project (HCHP).** In the fall of 1999, ATSDR initiated the HCHP to inform and educate individuals exposed to off-site releases of I-131 about associated health effects and healthcare options. By engaging the exposed population and their healthcare providers in an information sharing dialogue, the HCHP will help them make informed risk benefit decisions about their healthcare choices.

➢ **ATSDR birth cohort study.** A study of adverse autoimmune function and cardiovascular disease will (1) explore the potential relationship of radioactive releases, mainly I-131, into the environment and the prevalence of autoimmune diseases; (2) explore the potential relationship of radioactive releases, mainly I-131, into the environment and the prevalence of cardiovascular diseases; and (3) conduct comparative analysis.

The study population will consist of 2,000 persons randomly selected from six Washington State counties. The “high exposed” group will include persons who were born in Adams, Benton, or Franklin Counties between January 1, 1945, and December 31, 1951. The “low exposed” control group will include persons who were born in San Juan, Whatcom, or Mason Counties during the same period and did not live in any of the high exposure counties. The survey will be conducted using computer-assisted telephone technology.

➢ **ATSDR I-131 Subregistry.** ATSDR is developing the I-131 Subregistry to gain new scientific knowledge about health effects potentially associated with low-level, long-term, residential exposure to I-131, primarily from releases by Hanford. The I-131 Subregistry will collect information through personal and telephone interviews on 40 health outcomes, including thyroid diseases. The eligible population of approximately 17,000 persons are those who were (l) born in Adams, Benton or Franklin Counties between 1940 and 1951 or (2) 5 years old or younger and lived for more than 30 days in Adams, Benton, or Franklin Counties between 1945 and 1951. To date, 6,630 persons have been located, including 730 deceased. Since FY 1998, further activity on the I-131 Subregistry has been on hold pending funding from the DOE.

➢ **ATSDR *Case Studies in Environmental Medicine: Iodine-131 Toxicity*.** ATSDR is developing case studies in environmental medicine that focus on examples of patients with a history of exposure to radiation fallout. The case studies are in a self-training format and continuing medical education credits can be earned by using this training material.

➢ **ATSDR health education and promotion.** The findings from the Hanford Health Information Network Needs Assessment of Healthcare Physicians indicated that physicians wanted education about environmental exposures. (They were interested in radiation health effects and preferred self-instructional education methods). The agency will train healthcare providers and work with them to ensure they understand how information about exposures will improve patient care. This will be accomplished through ATSDR's partnering with existing local/state public health agencies and medical association programs.

The agency's new *Case Studies in Environmental Medicine: Iodine-131 Toxicity* will be an additional resource for the training of healthcare professionals. Implementation of training for healthcare professionals will be coordinated through the Hanford Health Effects Subcommittee (HHES) and the Hanford Community Health Project (HCHP).

➢ NCEH is completing its response to peer review of the Draft Final Report of the Hanford Thyroid Disease Study (HTDS) and will be disseminating the final report. (Note: Funding for HTDS was not from DOE.)

NIOSH Occupational Health Studies

➢ **Ionizing Radiation and Mortality among Hanford Workers (HANF).** The University of North Carolina, under a NIOSH grant, is updating a mortality study of Hanford workers. The study will reanalyze cancer and noncancer mortality from chronic, low-level external radiation exposure. New methods will be used to estimate doses previously assumed to be zero and to account for the effects of internal dose.

➢ **Multi-site Study of Heat Stress among Carpenters (HTST).** The United Brotherhood of Carpenters Health and Safety Fund, sponsored by a NIOSH grant, is studying heat stress among carpenters at several sites, including Hanford. The study measures physiologic and neurobehavioral changes in workers wearing protective clothing during actual working conditions. Carpenters and other construction workers in remediation and hazardous waste work will benefit from this information. Data collection and analysis are complete and the results will be disseminated in 2002.

➢ **Multi-site Case-control Study of Lung Cancer and External Ionizing Radiation (LUNG).** This ongoing NIOSH case-control study combines worker information from multiple sites, including Hanford, to clarify the relationship between lung cancer and external radiation exposure.

➢ **Multi-site Leukemia Case-control Study (LCCS).** This ongoing NIOSH case-control study combines worker information from multiple sites, including Hanford, to explore the relationship between external radiation and leukemia risk among 250 workers with leukemia compared to similar workers who do not have leukemia.

➢ **Exposure History for the Construction Trades (WHEP).** The University of Cincinnati, under a NIOSH grant, created an exposure history for the construction trades at Hanford, based on earlier work at the Oak Ridge Reservation. This project aimed to improve worker recall of complex occupational exposures across a large number of short-term workplace assignments. New techniques were used to establish guidelines and formats for personal work histories. This study is complete and the results will be distributed in 2002.

➢ **Comprehensive Occupational Safety and Health Surveillance System (COHS).** The University of Washington, under a NIOSH grant, designed and implemented a model occupational safety and health surveillance system at Hanford. This study gathered appropriate occupational medicine and industrial hygiene data to identify hazardous exposures and adverse health outcomes. An Employee Job Task Analysis process supports the objective evaluation of occupational health interventions through worker involvement in prevention efforts. This study is complete and the results will be distributed in 2002.

DOE Epidemiologic Surveillance of Current Workers

DOE's epidemiologic surveillance assesses the overall health of the *current* DOE work force at 14 DOE sites, including Hanford. The goal is to identify groups of workers that may be at increased risk for occupation-related injury and illness.

DOE Former Workers Medical Surveillance Program

- DOE, through its former worker program, is funding two projects at Hanford. The Hanford Building Trades Medical Screening Program collects information to determine if workers in the building trades (construction workers) from Hanford have health problems due to their employment at that site.

- The Medical Surveillance for Former Hanford Production Workers project will collect information to determine if former production workers and other non-construction workers from Hanford have health problems due to their employment at that site.

Issues Needing Attention at the Hanford Nuclear Reservation

The following issues need to be addressed in order to obtain more information:

- The impact of the Columbia River pathway on the health of Native Americans and others who may have extensively used the river needs to be evaluated.

- The natural history of thyroid abnormalities needs to be researched.

- Non-thyroid conditions potentially related to I-131 releases need to be analyzed. Direction for future community epidemiological studies may be identified through the I-131 subregistry when it is fully implemented and funded.

- A federally funded **medical monitoring program** was recommended by HHES. The ATSDR medical monitoring program is deferred, pending funding.

Proposed Activities at the Hanford Nuclear Reservation

Ongoing Activities

The agencies propose to continue the previously listed projects already underway. Ongoing projects include the following: ATSDR Public Health Assessment, Hanford Health Effects Subcommittee FACA, ATSDR tribal grants, NCEH followup to hot particle report, NCEH Web-based IDA project, ATSDR Hanford Commuity Health Project, ATSDR health education and promotion, NIOSH multi-site studies of Chemical Laboratory Workers, NIOSH Leukemia Case Control Study, and the NIOSH Lung Cancer Case Control Study.

New Activities for FY 2002–2007

ATSDR has developed plans for the I-131 subregistry and a medical monitoring program. These programs will be initiated if resources become available.

ATSDR Hanford Tracing. About 14,000 children who lived in areas downwind (Adams, Franklin and Benton Counties) of Hanford from 1945 to 1951 received the highest exposure to iodine-131. They were exposed primarily by drinking contaminated milk. Previously approximately 6,000 of the 14,000 children were traced. This project will attempt to trace or locate the 8,000 that have not been previously traced or located.

Idaho National Engineering and Environmental Laboratory (INEEL)

Idaho Falls, Idaho

Background

The Idaho National Engineering and Environmental Laboratory (INEEL) is on the upper Snake River Plain in the Arco Desert in southeastern Idaho, 4,900 feet above sea level. The 890-square mile site spans Butte, Bingham, Bonneville, Clark, and Jefferson Counties.

The federal government used the site in the 1940s as a gunnery test range. In 1949, the Atomic Energy Commission designated the site as the National Reactor Testing Station. Its mission was to develop and test nuclear reactors and related facilities. The first nuclear fuel was brought to the site in 1951, and radioactive waste disposal and storage began in 1954. There are eight major facilities at the site in Scoville, with offices in Idaho Falls.

Current programs include providing test irradiation services and radioisotope production for medical and commercial uses at the Advanced Test Reactor; processing radioactive wastes into solid form and storing them at the Idaho Nuclear Technology and Engineering Center; conducting light water-reactor safety testing and research; storing, processing, and monitoring radioactive wastes; and conducting environmental restoration. The Naval Reactors Program is also located at the site.

The community and INEEL workers are concerned about the potential health effects caused by releases of nitric oxides or radioactive fission products to the air from various facilities. They are also concerned about the potential for groundwater contamination, increased cancer incidence, and potential beryllium exposure.

Past Activities at INEEL

Off-Site Contamination

- In 1991, INEEL completed a 3-year effort to evaluate historical releases of radioactive materials and potential doses to a hypothetical individual who may have resided at an off-site location with the highest concentration of airborne radionuclides (less significant pathways to off-site radiation doses were not fully evaluated). Airborne releases were highest from 1955 through 1965. The most important radionuclides were iodine-129 and-131, cesium-137, strontium-90, and noble gases including krypton-88. The body organs receiving the highest doses were the thyroid and skin. However, the evaluation found that “radiation doses from airborne releases over the operating history of the INEEL were small compared to doses from natural background radiation” and

"the largest radiation doses were calculated for an infant in 1956 when the effective dose equivalent from operational and episodic releases was estimated to be 61 mrem." In that year doses to infants, the most sensitive population, were twice as high as doses to adults.

➢ The Idaho Department of Health and Welfare formed the Dose Evaluation Review and Assessment Advisory Panel to review the 1991 Historical Dose Evaluation and to make recommendations for future work. The advisory panel published its findings in 1993 and concluded that the following recommendations for future activities to reconstruct doses from toxic exposures to workers and members of the public potentially affected by INEEL should be implemented:

- Independent collection and verification of data,
- Comparisons between modeled and monitored data,
- Rigorous uncertainty analyses,
- Quality assurance program for all data collection and analysis,
- Dose reconstruction for all exposure pathways,
- Dose reconstruction for both radiation and chemical exposure, and
- Future studies to include full public participation.

➢ NCEH and its contractors located and catalogued several thousand documents which may potentially be used to calculate the extent of releases and exposures to the public. This document review started the INEEL dose reconstruction project.

Community Health Studies and Activities

➢ The Idaho Division of Environmental Quality INEEL Oversight Committee maintains monitoring stations around INEEL and frequently analyzes air, soil, and water samples around the laboratory.

➢ In response to community concerns about a brain cancer cluster, the Idaho Division of Health (IDH) conducted a Public Health Brain Cancer Study. The study evaluated people in six southeastern Idaho counties (including Moreland) who were diagnosed with brain cancer between 1978 and 1994. IDH found a high rate of brain cancer in the most recent data. However, the cancer cases could not be traced to a common event and therefore could not be associated with a singular cause. IDH presented the results of the study to the Idaho Health Effects Subcommittee in December 1997.

➢ The Idaho Department of Health and Welfare reviewed cancer morbidity and mortality data in Clark and Minidoka, two counties near INEEL. Clark County lies northeast of INEEL, and Minidoka County is southwest of INEEL. Cancer death rates were examined for 1950–1989, and cancer incidence rates were examined for 1978–1987 to determine if any significant trends in cancer morbidity and mortality could be observed in these counties compared with the state. No statistically significant differences in age-

and sex-adjusted death rates were observed in either county. However, when cancer incidence data were considered, the overall cancer incidence rate in Clark County was higher than expected based on the state rate for female breast cancer and lip cancer.

➢ Jablon et al. (*JAMA*, 1991:1403–1408) examined cancer mortality in populations living near nuclear facilities in the United States, including INEEL. Cancer mortality rates in 107 counties near 62 nuclear facilities were compared with cancer mortality rates in control counties that were not near nuclear facilities. Rates were compared for 1950–1984. Cancer mortality for Bingham, Butte, and Jefferson Counties, where INEEL is located, was compared with nine control counties with similar demographic characteristics in the same region. No general association was detected between residence in a county with a nuclear facility and death attributable to leukemia or any other form of cancer. Interpretation of the study results was limited by the study's ecological approach in which the exposures of individuals are not known.

Studies of the Health of INEEL Workers

➢ A study of the potential association between paternal exposure to ionizing radiation and risk of childhood cancer found no link between brain cancer or leukemia and paternal employment at INEEL. Children whose fathers worked at Hanford were more likely to get central nervous system cancer than children whose fathers worked at other sites, including INEEL, but this finding was based on small numbers and was not statistically significant.

➢ **Prevention of Stress and Health Consequences of Downsizing (STDN).** The effects of downsizing on organizational climate, worker health, and performance were studied at several DOE sites, including INEEL. Data gathering included interviews, workplace observations, employee discussion groups, an employee survey distributed to more than 10,500 employees, and a historical record review. Researchers identified opportunities to reduce job stress that could lead to improved employee health and organizational well-being. Suggested intervention strategies were proposed for further research.

➢ **Exposure Assessment of Hazardous Waste, Decontamination and Decommissioning, Cleanup Workers (HAWW).** Feasibility studies at seven DOE sites, including INEEL, determined that the availability of records to identify workers and their primary activities, exposures, work histories, and medical information varied significantly from site to site. The necessary information to conduct exposure assessment, hazard surveillance, or epidemiology studies of remediation workers is currently not readily available. Within sites, data systems are fragmented and data management is inconsistent in the current environment of decentralized management and increased subcontracting.

Current Activities at INEEL

Community Involvement

INEEL Health Effects Subcommittee. ATSDR and NCEH will continue to work with the INEEL Health Effects Subcommittee, which serves as a vehicle for the public and tribal nations to express concerns and provide advice and recommendations on the agencies' public health activities and research at INEEL.

Off-Site Contamination

- **NCEH dose reconstruction.** NCEH has completed a screening analysis of releases identified by the INEEL Environmental Dose Reconstruction document search to determine which contaminants and exposure pathways have the highest potential for affecting the public. NCEH contractors, using the documents found in the first phase of this research, have listed, in order of importance, the chemicals and radionuclides released from INEEL over the years based on screening calculations for representative persons and exposure scenarios. Working with the INEEL Health Effects Subcommittee, the results of these screenings have been used to develop dose reconstruction projects for a limited number of locations on site, contaminants, and years of release that will be used to guide decisions on future INEEL dose reconstruction activities.

- **ATSDR public health assessment.** ATSDR continues to work on the public health assessment for INEEL including evaluating past, present, and future exposure pathways.

- **ATSDR health education and promotion.** ATSDR continues to develop health education programs for healthcare providers and the potentially affected community. ATSDR is collaborating with the INEEL Health Effects Subcommittee (HES), other federal and state public health agencies, and community partners to carry out health education activities. An INEEL HES Health Education Working Group (working within the Education and Outreach Working Group) has been formed to identify and prioritize the communities potentially affected by INEEL and to design a strategy to develop health education activities specific to those communities. The working group is currently reviewing the health education needs assessment, which will enable ATSDR to formulate specific health education programs for communities and their healthcare providers. ATSDR and the INEEL Health Education Working Group are also planning public availability sessions in anticipation of the release of the Public Health Assessment, as well as other community activities to promote ATSDR health education activities at the site.

Community Health Studies and Activities

ATSDR health studies. The Idaho Department of Health is studying the prevalence of brain cancer. DHHS reviewed the questionnaire that was being used by Idaho before the study began. ATSDR might be asked to review the completed study.

NIOSH Occupational Health Studies

- **Cohort mortality study of Idaho National Engineering and Environmental Laboratory (INEL).** The mortality experience of INEEL workers has not been previously studied. NIOSH is conducting a mortality study of over 70,000 INEEL workers. Worker exposures to external ionizing radiation and a variety of chemicals are being evaluated.

- **International Collaborative Study of Nuclear Industry Workers (IARC).** NIOSH will contribute data from the INEEL study cohort (above) to an international collaborative study of nuclear workers in 17 countries. This study sponsored by the International Agency for Research on Cancer is the largest cancer mortality study of nuclear workers.

- **Multi-site Case-control Study of Lung Cancer and External Ionizing Radiation (LUNG).** This ongoing NIOSH case-control study combines worker information from multiple sites, including INEEL, to clarify the relationship between lung cancer and external radiation exposure.

DOE Epidemiologic Surveillance of Current Workers

DOE's epidemiologic surveillance assesses the overall health of the *current* DOE work force at 14 DOE sites, including INEEL. The goal is to identify groups of workers that may be at increased risk for occupation-related injury and illness.

DOE Former Workers Medical Surveillance Program

- A DOE-funded study, *Medical Surveillance for Former Idaho Falls, Idaho, Workers*, will attempt to determine whether former hourly and salaried workers from INEEL might have health problems due to employment at the site. The project is being carried out by a group of investigators from the Paper, Allied-Industrial, Chemical and Energy Workers International Union; the University of Massachusetts at Lowell; and Queens College, City University of New York. Phase I of this project includes collecting and evaluating existing information from the site; completing a mail questionnaire survey of a large sample of former nuclear workers from the site; holding focus group and risk-mapping sessions for former workers; and preparing a list of healthcare providers and community resources in the area near the site. During Phase II of the project, the investigators will decide which workers might possibly be at significant risk for health

problems related to their exposure, and those workers will have an opportunity to participate in a free medical screening program.

Issues Needing Attention at INEEL

Depending on the results of the environmental dose reconstruction, a determination may need to be made on the potential health effects that might result from past exposures to chemicals and radionuclides released from the site to the surrounding communities.

Proposed Activities at INEEL

Ongoing Activities

The agencies propose to continue the previously listed projects already underway.

New Activities for FY 2002–2007

No new activities are proposed at this time.

Laboratory for Energy-Related Health Research (LEHR)
Davis, California

Background

The Laboratory for Energy-Related Health Research (LEHR) was a Department of Energy (DOE) research facility, located on property owned by the University of California at Davis (UCD), in Solano County, in the city limits of Davis, California. DOE and its predecessor, the Atomic Energy Commission, funded the laboratory primarily to investigate the long-term effects of low levels of radium-226 and strontium-90 in beagles.

The 15-acre site is near existing UCD landfills, and a portion of the dog pen area was built over a part of the landfills. The main UCD campus lies north of the site, and the property west, south, and east of the site is used for farming. The south fork of Putah Creek flows east approximately 250 feet from the southern boundary of the site. Today, UCD operates the Institute of Toxicology and Environmental Health at the site.

Animal wastes generated during LEHR activities were placed in holding tanks, trenches, boreholes, and the UCD landfills near the LEHR animal pens and laboratories. Restoration of the site, including the removal of some buildings, cages, and the contents of waste tanks, began in 1990. Generally, DOE is responsible for cleanup of site soils and UCD is responsible for cleanup of groundwater.

Past Activities at LEHR

Off-Site Contamination

- In a site summary document, the Agency for Toxic Substances and Disease Registry (ATSDR) identified the following public health concerns: nitrate and organic chemicals in groundwater, and potentially contaminated fish in Putah Creek.

- Putah Creek fish were collected and tested for potential mercury and lead contamination. ATSDR concluded that elevated levels of mercury in large-mouth bass are a public health hazard to fetuses and nursing infants whose mothers eat large-mouth bass from the creek.

- Yolo County sponsored a Putah and Cache Creek Ecotoxicity Project which was conducted by the Central Valley Regional Water Quality Control Board. The *Cache Creek and Putah Creek Watersheds Toxicity Monitoring Results: 1998–1999 Final Report* was released on November 30, 2000.

Community Health Studies and Activities

➢ No studies on the health of residents living near the laboratory exist.

Studies of the Health of LEHR Workers

➢ No studies on the health of LEHR workers exist.

Current Activities at LEHR

Community Involvement

➢ ATSDR is working with the Davis South Campus Superfund Oversight Committee to identify and address community health concerns.

Off-Site Contamination

➢ **ATSDR public health assessment.** ATSDR is conducting a public health assessment of the site to assess the public health impact of off-site releases of hazardous and radioactive materials. The findings of the past health consultations will be incorporated into a public health assessment document that will address all exposure pathways for the site. The document will address the site's impact on Putah Creek water quality and health implications on the residents who eat the Putah Creek fish and who use the creek for recreation. The document will also address community concerns, including, mercury contamination, and bioaccumulation of chlorinated hydrocarbons, pesticides, dioxins, and polychlorinated biphenyls.

Community Health Studies and Activities

➢ The California Department of Health Services (CDHS), Environmental Health Investigations Branch, through a cooperative agreement with ATSDR, prepared a health consultation and a fact sheet on nitrate in drinking water, which were distributed to the community surrounding the site and to other areas of the state.

➢ **ATSDR health education and promotion.** ATSDR will determine its community involvement and health education activities based on the findings and recommendations from the draft public health assessment and comments received from community residents during the public comment release period. These activities could include holding a public availability session for residents impacted by LEHR and developing community health educational materials which may include fact sheets, educational brochures, and document summaries.

Occupational Health Studies

➢ No occupational health studies currently exist for the site.

Issues Needing Attention at LEHR

As the public health assessment for the site continues, specific data gaps will be identified for which agencies will develop proposed activities.

Proposed Activities at LEHR

Ongoing Activities

The agencies propose to continue the previously listed projects already underway.

New Activities for FY 2002–2007

No new activities are proposed at this time.

Lawrence Livermore National Laboratory (LLNL)
Livermore, California

Background

The Lawrence Livermore National Laboratory (LLNL) site consists of two separate parcels: the main site and site 300. The 826-acre main site is located in the flat land of the Livermore-Amador Valley in Alameda County, on the eastern edge of the city of Livermore, approximately 40 miles east of San Francisco, California. Site 300 is approximately 15 miles east of the main site and occupies approximately 7,000 acres in Alameda and San Joaquin Counties. The terrain consists of rolling hills and canyons at elevations ranging from 525 to 1,750 feet above sea level.

In 1942, the land was converted from agricultural use to a naval flight training base and aircraft assembly and repair facility. Since 1951, the site has been an active, multi-program research facility operated by the University of California for the Department of Energy (DOE). The laboratory's mission is research and education in defense, biomedicine, energy, magnetic fusion, lasers, and the environment.

A number of operations at LLNL handle or generate hazardous materials, radioactive wastes, and mixed wastes. Activities from naval operations prior to 1951 and activities from LLNL since that time have resulted in on- and off-site contamination and potential exposure to both workers and local residents.

Local residents are particularly concerned about radiological contamination in parks and other public areas in and around Livermore. Additional community concerns include (1) the contamination of municipal and residential water supplies; (2) air releases of tritium, depleted uranium, and beryllium during non-nuclear testing of weapons systems at site 300; (3) air releases of radioactive and hazardous materials from the main site, especially tritium; (4) water contamination by tritium at site 300; (5) plutonium-239 in municipal sewage sludge that was distributed to municipal and private users as a soil amendment; (6) radiological measurements in sewage effluent and sludge from Pleasanton's Sunol Avenue sewage treatment plant; and (7) the health impacts, including cancer, noncancer diseases, and developmental disabilities.

Past Activities at LLNL

Off-Site Contamination

- In September 1984, the California Department of Health Services (CDHS) issued an Order for Compliance to LLNL to provide alternative water supplies to residents west of the facility whose wells had been contaminated by hazardous substances from the site. The order also directed LLNL to conduct a groundwater investigation.

- In November 1985, the California Regional Water Quality Control Board issued an order directing LLNL to investigate and clean up the on- and off-site groundwater contamination. LLNL began investigating the source and the vertical and lateral extent of the contamination of soil and groundwater.

- In 1986, a plume of groundwater contaminated with volatile organic compounds, including tetrachloroethylene, was found to have migrated 3,600 feet west of the main site. Sampling of water from monitoring wells at the main site found contamination by tetrachloroethylene, trans-1, 2-dichloroethylene, and trichloroethylene. Soil on the site was also contaminated.

- CDHS, under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR), prepared a health consultation which concluded that public water supplies near the main site have not been impacted by groundwater contamination from the site. CDHS also identified private water wells that may be impacted by groundwater contamination from the main site and recommended that ATSDR evaluate them further. Subsequent investigation conducted by CDHS determined that all potentially impacted private off-site water wells have been sealed and abandoned by LLNL following State of California rules and regulations. Therefore, there is no threat to human health from these wells.

- **CDHS consultation.** In 1998, CDHS, under a cooperative agreement with ATSDR, prepared a health consultation addressing plutonium in Big Trees Park in Livermore. Plutonium-239 in surface soils in the park was at levels that do not pose a public health hazard. The consultation identified possible pathways for contamination of the park, including aerial dispersion, sediment distribution from an adjacent creek channel, and use of contaminated sewage sludge as fill material. DOE conducted additional soil sampling for plutonium in the park. ATSDR evaluated these data to determine the (1) health impacts to park users, (2) distribution of plutonium within the park, and (3) pathways by which contamination may have reached the park. ATSDR has incorporated the findings into an addendum to the 1998 health consultation.

Community Health Studies and Activities

- In a 1995 health study, CDHS, with assistance from the Centers for Disease Control and Prevention (CDC), investigated the 1960–1991 cancer incidence for children and young adults who lived in Livermore. CDHS reported an elevated rate of melanoma when compared to rates in Alameda County.

- In 1996, in response to community concerns about elevated cancer rates in the Livermore area, CDHS, with assistance from CDC, assessed the 1988–1993 incidence of invasive cancers in residents of eight census tracts that include Livermore and the surrounding area. The incidence of cancers was not found to be elevated among these

residents compared to the rates of Bay Area residents. The incidence of melanoma was elevated in one tract located west of the main site, although the elevation was not statistically significant.

➢ In March 1999, the California Birth Defects Monitoring Program (CBDMP) examined birth defects in zip codes 94550 and 94551 around Livermore for 1983–1989 (the only years that CBDMP operated in Alameda County). CBDMP found no evidence of increased rates of birth defects among people living around Livermore.

Studies of the Health of LLNL Workers

➢ In 1980 and 1982, CDHS determined that the incidence of malignant melanoma was higher for LLNL employees than for the population of the region. For the 19 cases diagnosed from 1972 to 1977, work involving exposure to ionizing radiation was not associated with a diagnosis of melanoma; however, working as a chemist was. In 1984, based on a review of records for persons with and without melanoma, occupational factors were reaffirmed as being associated with melanoma risk. Later, when the incidence rates for LLNL workers were calculated for 1969–1980, higher rates were found for cancers, in addition to malignant melanoma. The incidence rates for salivary gland cancer and rectal cancer among female laboratory workers were above the rates for the region. For male laboratory workers, other nervous system tumors, excluding brain tumors, were higher than expected.

➢ Thirty-one laboratory workers with malignant melanoma and a control group were interviewed about personal and occupational factors that might be associated with the disease. The following factors were more common than expected among persons with malignant melanoma: (1) exposure to radioactive materials, (2) work at Site 300, (3) exposure to volatile photographic chemicals, (4) participation at the Pacific Test Site, and (5) chemist duties. The most recent interview study of 69 cases and an equal number of controls found that differences in personal factors, genetics, and recreational use of the outdoors were consistent with what is known about malignant melanoma of the skin. Only occupational exposure to alcohols, out of 39 industrial exposures examined, was more common among persons with melanoma.

➢ Studies of the microscopic features of the melanoma tumors indicated that the tumor thickness for laboratory workers was significantly less than for individuals who did not work at LLNL, up to the time when the concern became public in 1977. These data were taken as evidence of earlier detection of tumors at LLNL. A greater proportion of workers hired before 1962, who were engineers, particularly electrical engineers, had dark moles or pigmented nevi that are associated with a high risk of malignant melanoma.

Current Activities at LLNL

Community Involvement

ATSDR site team. ATSDR, with assistance from CDHS, established a site team, which included representatives from the community, local and national interest groups, and local, state, and federal government agencies, to identify issues and set priorities in the ATSDR public health assessment process. ATSDR conducts meetings of the site team and provides written updates in the intervals between the team's meetings. Meetings are held in the evening and are open to the public, and some site team meetings have had as many as 100 persons in attendance.

Through its site team meetings, ATSDR provides information on exposure and health issues of interest to team members, including basic information about radiation exposures and health effects. ATSDR also provides public health statements on plutonium, uranium, and trichloroethylene.

Off-Site Contamination

➢ **ATSDR public health assessments.** ATSDR is conducting public health assessments of the main site and site 300 to evaluate the public health impact of off-site releases of hazardous and radioactive materials. Pathways of concern are initially being addressed as a series of health consultations. The findings of the health consultations will be incorporated into a public health assessment document that will address all exposure pathways for the site.

➢ **ATSDR expert panel and health consultation on tritium releases.** In response to community concerns about the effect of organically bound tritium on total tritium doses, ATSDR convened a panel of tritium experts and site and community representatives to evaluate cumulative tritium doses. The panel report is currently undergoing final revisions and ATSDR's summary of the report will be released as a public health consultation.

Community Health Studies and Activities

➢ **ATSDR health education and promotion.** Upon completion of the public health assessment, ATSDR will conduct a health education needs assessment in consultation with community organizations and appropriate state agencies to assess health education needs for the community and healthcare professionals. On the basis of this needs assessment, ATSDR will develop a program to regularly provide information and training that will enable healthcare providers to take an exposure history and promote behavioral changes that will be health-protective.

DOE Epidemiologic Surveillance of Current Workers

DOE's epidemiologic surveillance assesses the overall health of the *current* DOE work force at 14 DOE sites, including LLNL. The goal is to identify groups of workers that may be at increased risk for occupation-related injury and illness.

Issues Needing Attention at LLNL

As the public health assessment and the epidemiologic surveillance program for the LLNL sites continue, specific data gaps will be identified. The agencies will develop proposed activities to address these data gaps.

Proposed Activities at LLNL

Ongoing Activities

The agencies propose to continue the previously listed projects already underway and to initiate new ones. Such activities will be implemented only if feasible and deemed appropriate and beneficial to the community. The agencies will establish a coordinated plan, schedule, and lead organization for each new public health activity. The plan and schedule will be presented to all potential partners for their comment.

New Activities for FY 2002–2007

No new activities are proposed at this time.

Los Alamos National Laboratory (LANL)

Los Alamos, New Mexico

Background

The Los Alamos National Laboratory (LANL) comprises about 43 square miles (27,500 acres) in Los Alamos and Santa Fe Counties, New Mexico. It is situated on a volcanic plateau composed of a number of mesas separated by steeply sloped and deeply eroded drainage canyons oriented from west to east. The town of Los Alamos had a population of approximately 19,000 people in 1990. Albuquerque (60 miles south) and Santa Fe (25 miles southeast) are the closest metropolitan areas. Several Native American pueblos reside near the site.

Public health issues of concern include the potential health effects in the neighboring populations from current and past releases of radioactive and hazardous materials. The major source of current radiological atmospheric releases is the Los Alamos Neutron Science Center, formerly known as the Los Alamos Meson Physics Facility, which accounts for 95% of current air releases, primarily radioactive gases. Other air releases come from incinerators which had been used from 1951 to the early 1990s to recover plutonium, the Omega West Reactor which was defueled in 1993, the Chemical and Metallurgical Research Building, located in Technical Area 3 (TA), the HP Site (TA-33), and the former DP site (TA-21).

Possible sources of groundwater contamination are the active waste disposal area (TA-54, Area G); firing sites in Bayo Canyon (used during 1944–1962 and beyond), which included underground testing and radioactive lanthanum (RaLa) implosion tests releasing lanthanum-140 (La-140), strontium-90, and depleted uranium; atmospheric tracking tests conducted in 1950 which released La-140; and outfall pipes discharging laboratory wastes and other liquid wastes directly to Acid and Pueblo canyons. Mortandad Canyon received direct discharges of both hazardous and radioactive liquid wastes.

On May 4, 2000, the National Park Service initiated a planned burn of accumulated deadwood and undergrowth in a 3000-acre area near Cerro Grande Peak in the Bandelier National Monument. This peak is almost immediately due west of LANL. As a result of low humidity and high winds, the fire spun out of control and burned a larger area than originally planned. The fire was officially declared out of control on May 5, 2000, and declared fully contained on June 6, 2000. The fire burned parts of the Bandelier National Monument, the Santa Fe National Forest, LANL, the Santa Clara Pueblo, private lands, and homes in the town of Los Alamos. The fire eventually burned between 43,000 and 48,000 acres and destroyed or damaged 235 residential structures in the town of Los Alamos and 112 LANL buildings.

Many of the people in the Los Alamos area are concerned about the possibility of radioactive and non-radioactive hazardous material releases from the fire burning through LANL. The fire

burned many buildings on-site, including several involved in the creation of the first atomic bombs. It also burned areas where radioactive material or other hazardous material had been disposed of during the operation of LANL. In February 2001, the New Mexico Environment Department (NMED) contracted with Risk Assessment Corporation to independently evaluate the immediate consequences and long-term impacts of the fire. The evaluation will be completed in 2002. Draft reports are available on the Internet site of the NMED.

Past Activities at LANL

Off-Site Contamination

- **Agency for Toxic Substances and Disease Registry (ATSDR) exposure investigation.** The investigation which sampled San Ildefonso lands adjacent to the laboratory, found elevated levels of plutonium in surface water and elevated concentrations of plutonium-239 and cesium-137 in sediment. Although these levels were higher than background levels, they are not at levels known to adversely affect public health.

- **ATSDR health consultation on Acid Canyon.** ATSDR determined that levels of plutonium in Acid Canyon were not a public health hazard for recreational users.

- **ATSDR health consultation on tritium in groundwater.** Although tritium was detected in groundwater wells, including monitoring wells, residential wells, and Los Alamos water supply wells, ATSDR determined that the water in the wells was safe for drinking.

- **ATSDR health consultation on nitrates in groundwater.** ATSDR recommended eliminating potential exposure to nitrates for infants less than 4 months of age, as they are the most sensitive population.

Community Health Studies and Activities

- In response to community concerns over a perceived excess of brain tumors and their relationship to radiologic contaminants from LANL, the New Mexico Department of Health, with funding from the Department of Energy (DOE), reviewed cancer rates in Los Alamos County. The 1993 health study determined that incidence of brain cancer was not elevated, but that the incidence of thyroid cancer was elevated beginning about 1980, with an excess incidence from 1988–1993, and a decline thereafter. No single factor could explain the higher rates.

  Further analyses of incidence and mortality data, and tumor characteristics were conducted for eight specific cancer sites or types. Rates generated for Los Alamos County and its census districts were based on a very small number of cases. Therefore,

it could not be determined if these unstable rates reflected random variation or true trends in underlying cancer risk.

➢ In FY 1997, ATSDR conducted a needs assessment for a number of communities in the Los Alamos area. Based on the findings of the needs assessment, ATSDR, the Centers for Disease Control and Prevention's National Center for Environmental Health (NCEH), and the Centers for Disease Control and Prevention's National Institute for Occupational Safety and Health (NIOSH) have developed plans for conducting community involvement and health education activities.

➢ In September 1995, ATSDR sponsored a workshop for pueblo and rural communities, attended by about 60 people who received environmental health information on chemical and radiation exposure.

➢ **NCEH community education through Rio Arriba partnership, University of New Mexico.** NCEH awarded a 3-year grant to the Rio Arriba Environmental Health Partnership at the University of New Mexico to conduct community education and training related to environmental health research near LANL.

Studies of the Health of LANL Workers

➢ The cause-specific mortality rates for all 15,727 LANL white male employees were similar to the rates for the U.S. population through 1990. Positive trends in the mortality rate with increasing external radiation dose were reported for cancers of the brain and central nervous system, esophagus, and Hodgkin disease. There was an association between increasing doses of external radiation and kidney cancer, as well as lymphocytic leukemia among workers who were not exposed to plutonium. However, the mortality rates were not elevated according to statistical tests.

➢ There were 5,424 Zia Company employees monitored for exposure to either plutonium or external ionizing radiation. Mortality was studied up to the end of 1984. Hispanic males had high mortality rates for stomach cancer, all injuries, all accidents, and motor vehicle accidents. Non-Hispanic males had high mortality rates from all causes, all cancers, lung cancer, all circulatory diseases, and all respiratory diseases.

➢ A cohort of 224 employees at LANL and Zia Company with a 10 nanocurie or greater internal deposition of plutonium was studied up to the end of 1980. Their mortality experience was compared to the U.S. population and to a group of workers not exposed to radiation. No cause of death was reported as higher than the comparison groups.

➢ The mortality of 6,970 females workers at LANL was studied up to the end of 1981. The death rate from suicide was higher among women monitored for radiation exposure

than the comparable U.S. population rate. This finding was not related to duration of employment or plutonium exposure.

- A reported excess number of cases of skin cancer (malignant melanoma) among Lawrence Livermore National Laboratory employees motivated scientists to conduct a similar investigation among LANL employees. No excess skin cancer was detected among the 11,000 workers studied between 1969 and 1978. An in-depth study of 15 LANL employees with skin cancer found no link between the cancer and exposure to external radiation.

- A multi-site study of multiple myeloma (a blood cell cancer) reported that the myeloma death rate at LANL was not different from the U.S. population rate. However, external radiation exposures received at age 45 years or older were associated with a higher risk of dying from myeloma.

- **Prevention of Stress and Health Consequences of Downsizing (STDN).** The effects of downsizing on organizational climate, worker health, and performance were studied at several DOE sites, including Los Alamos. Data gathering included interviews, workplace observations, employee discussion groups, an employee survey distributed to more than 10,500 employees, and a historical record review. Researchers identified opportunities to reduce job stress that could lead to improved employee health and organizational well-being. Suggested intervention strategies were proposed for further research.

- **Study of Mortality Among Female Nuclear Workers (MAFN).** A study of female workers from 12 DOE plants, including LANL, was combined in a cohort mortality study, and risk estimates were developed for exposure to ionizing radiation or to chemical hazards. For the entire pooled cohort, mortality from mental disorders, diseases of the genitourinary system, and from ill-defined conditions was higher than expected. External ionizing radiation exposure in these workers appeared to be associated with increased relative risk for leukemia and, to a lesser degree, with increased relative risks for all cancers combined and for breast cancer.

Current Activities at LANL

Community Involvement

- ATSDR, NCEH, and NIOSH will continue to work with community-based organizations, such as the Northern Pueblos Institute, the New Mexico Educational Opportunity Center, the Tribal Environmental Watch Alliance, the Rio Arriba Environmental Health Partnership, the Eight Northern Indian Pueblos Council, and the Los Alamos Citizens' Advisory Board, to address current progress and future plans.

Off-Site Contamination

➢ **NCEH historical document retrieval for dose reconstruction.** NCEH has initiated this project at LANL, which began in FY 1999 and is expected to continue for at least 3 years. This project will locate, copy, and evaluate documents that contain information about historical chemical or radionuclide releases from LANL to the environment. NCEH will work with Los Alamos stakeholders to determine if the information warrants an off-site exposure assessment.

➢ **ATSDR public health assessment.** In 1991, former Congressman Richardson petitioned ATSDR to conduct a public health assessment to assess the potential public health impact for off-site releases of hazardous materials. To avoid any duplication of efforts, ATSDR will use the data and information collected by NCEH during the dose reconstruction activity. Public health assessment activities can include current exposure assessments made by direct sampling (for example, the San Ildefonso sampling). The public health assessment process can also provide current sampling to validate dose reconstruction models as was done at the Fernald site. ATSDR will provide health consultations to DOE and the community as requested. These consultations will evaluate and address specific questions regarding site remediation or community concerns.

Community Health Studies and Activities

➢ **ATSDR health education and promotion.** ATSDR provides support health education activities through a cooperative agreement with the Association of Occupational and Environmental Clinics (AOEC). These activities include both healthcare provider education and community health education. Under the AOEC cooperative agreement, the Community Environmental Health Program at the University of New Mexico Center for Population Health is developing environmental health training modules. The project includes:

- Developing a home/neighborhood environmental health assessment tool,
- Providing additional training to primary healthcare providers and lay health workers, and
- Formalizing a pilot project to incorporate lay environmental health workers into the clinic setting.

➢ **ATSDR health studies.** Health studies will be determined based on the findings of the public health assessment.

NIOSH Occupational Health Studies

➢ **Leukemia Case-control Study (LCCS).** An ongoing NIOSH leukemia case-control study will combine worker information from several DOE sites, including LANL.

This study, the largest of its kind, will examine the relationship between external radiation and leukemia risk among 250 workers with leukemia compared with workers who do not have leukemia.

➢ **Hazard Surveillance in the Defense Nuclear Industry (HSDN)—Exposure Assessment Models.** The University of Southern California is developing an integrated approach to statistical exposure assessment models of complex mixed exposures to chemical and biochemical agents. Based on task-specific exposure measurements, this NIOSH-sponsored project attempts to identify and develop appropriate statistical tools for the modeling of single-and mixed-agent exposures and resulting internal doses. The resulting system will provide a risk-based assessment of possible adverse health outcome incidence to guide interventions and medical surveillance.

DOE Former Workers Medical Surveillance Program

➢ Phase I of the DOE Former Worker Medical Surveillance Project at LANL reviewed information that will be used to determine if former laboratory workers have health problems related to their employment at the laboratory. The focus is on former machinists and workers exposed to beryllium. This project is being carried out by investigators from The Johns Hopkins University; the Laborers' Health and Safety Fund of North America; the Environment, Safety, and Health Division of Los Alamos National Laboratory; and the National Jewish Medical and Research Center.

Phase I of this project includes these major tasks: (1) reviewing the site history to determine if there were potentially hazardous exposures; (2) locating existing sources of health data related to former workers; and (3) developing a method for contacting former workers. During Phase II of the project, the investigators will determine which workers have health problems most probably related to their exposure. Those workers will be offered an opportunity to participate in a free medical screening program.

➢ DOE Beryllium Workers Medical Surveillance Program (1) identifies and locates workers exposed to beryllium; (2) provides enhanced medical monitoring for early identification of chronic beryllium disease (CBD); and (3) characterizes employees' occupational exposures to beryllium during current and past operations. The program is currently operating at the Oak Ridge Y-12 Plant, the Rocky Flats Plant, and LANL. More than 20,000 current and former workers have been contacted to date. About 7,000 have responded. More than 100 cases of chronic beryllium disease have been detected complex-wide. At the same time, the Los Alamos Beryllium Worker Health Surveillance Program is evaluating the validity and positive predictive value of a new blood test (the flow cytometry-based lymphocyte proliferation test) in screening for CBD.

Issues Needing Attention at LANL

The following issues need to be addressed:

- The increased rates of cases of thyroid and other cancers seen during the 1980s and the subsequent decrease in those rates need to be explained.
- Concerns about benign thyroid condition in communities at large, and specifically among residents of the pueblos need to be addressed.
- Soil exposure pathways need to be reviewed.
- An apparent cluster (four confirmed cases) of leiomyosarcoma in Los Alamos needs to be investigated.
- Concerns about air pathways associated with the incinerator, including historical concentrations of dioxin, need to be addressed.

Proposed Activities at LANL

Ongoing Activities

The agencies propose to continue the previously listed projects already underway.

New Activities for FY 2002–2007

No new activities are proposed at this time.

Mallinckrodt Plant
St. Louis, Missouri

Background

The 45-acre Mallinckrodt Plant is located in an industrial area on the eastern border of St. Louis, approximately 300 feet west of the Mississippi River. The property is owned and operated by Mallinckrodt, Inc. (formerly Mallinckrodt Chemical Works).

From 1942 to 1957, under contracts with the Manhattan Engineer District (MED) and the Atomic Energy Commission (AEC), the site processed various forms of uranium compounds for machining and for recovery of uranium metal. In 1946 the manufacture of uranium dioxide from pitchblende ore began at a newly constructed plant. The pitchblende ore was acquired from the African Metals Company. Because this company retained ownership of the radium content of the ore, radium-226 and its daughter products had to be extracted along with the lead content. The radium and lead were precipitated, and the precipitate was stored at the Lake Ontario Ordnance Works in Lewiston, New York, and the Feed Material Production Center in Fernald, Ohio.

Mallinckrodt now owns the buildings formerly used under the AEC contract. At the time of the MED/AEC operations, the plants were owned by Mallinckrodt and/or leased by AEC. Certain buildings in those plants were also constructed for and owned by AEC. From 1942 through 1945, uranium processing was conducted at Plants 1, 2, and 4. In 1945 operations at Plant 2 were terminated. Some uranium metallurgical research continued at Plant 4 through 1956. From 1945 to 1957, uranium concentrate or ore was processed in buildings at Destrehan Street (Plants 6, 6E, and 7). All uranium extraction operations at the Destrehan Street location ceased in 1957.

Past Activities at Mallinckrodt

Studies of the Health of Mallinckrodt Workers

- A study conducted by Oak Ridge Associated Universities (Dupree et al., 1995), under contract to the Department of Energy (DOE) Office of Energy Research, examined the relationship between uranium dust exposure and lung cancer mortality among workers employed in four uranium processing or fabrication operations located in Missouri, Ohio, and Tennessee. This study included the Mallinckrodt facility. A total of 787 cases were identified. Odds ratios for lung cancer mortality for seven cumulative internal dose groups did not demonstrate increasing risk with increasing dose. However, there was a suggestion of an exposure effect for workers hired at age 45 years or older. Further analyses for cumulative external dose and exposures to thorium, radium, and radon did not reveal any statistically significant association between exposure and increased risk, nor did categorizing workers by facility.

The study results were published in the journal *Epidemiology* (Dupree EA, Watkins JP, Ingle JN, Wallace PW, West CM, Tankersly WG . Uranium dust exposure and lung cancer risk in four uranium processing operations. *Epidemiology* 1995;6(4):370–5).

➢ A study conducted by Oak Ridge Associated Universities (Dupree EA, 2000), under contract to NIOSH, investigated the mortality in a cohort of 2,514 white males employed at Mallinckrodt between 1942 and 1966 to evaluate: (1) mortality compared to the U.S. population, and (2) the relationship between external ionizing radiation and cancer and other disease of the respiratory, digestive, genitourinary, and lymphatic systems. A total of 1,013 deaths occurred among this cohort through 1993. For all causes of death, fewer white male workers died than would be expected based on the U.S. white male population (SMR = 0.90, 95% CI = 0.85-0.96). The SMR for all cancer deaths was elevated but not statistically significant (SMR = 1.05, 95% CI = 0.93-1.17) as was chronic nephritis (SMR = 1.88, 95% CI = 0.75-3.81).

The study results were published as follows: (1) Dupree EA, Watkins JP, Ingle JN, Phillips JA. *External radiation exposure and mortality among a cohort of uranium processing workers*. Oak Ridge, TN: Oak Ridge Associated Universities; 1998 (HHS Contract #200-93-2695, Final Report.) Available from the Centers for Disease Control and Prevention's National Institute for Occupational Safety and Health/Health-related Energy Research Branch, Cincinnati, OH, (26 pg.) and (2) Dupree EA, Watkins JP, Ingle JN, Phillips JA. External radiation exposure and mortality in a cohort of uranium processing workers. *Am Epidemiol*, 2000;152:91-5.

Current Activities at Mallinckrodt

No studies are currently being conducted in populations near the site.

Issues Needing Attention at Mallinckrodt

No additional issues have emerged.

Proposed Activities at Mallinckrodt

New Activities for FY 2002–2007

NIOSH Occupational Health Studies (2004–2005) Mallinckrodt Exposure Assessment Study (MALN). Further investigation of this important uranium exposure cohort is anticipated to more fully characterize internal exposures such as radium, radon, and uranium that were encountered by the workers at this facility.

Middlesex Sampling Plant (MSP)

Middlesex, New Jersey

Background

The Middlesex Sampling Plant (MSP) is located in the Borough of Middlesex, New Jersey. The plant is in the Raritan River drainage basin, and runoff from the site flows south into the Raritan River through a series of ditches, streams, and brooks.

From 1943 to 1967, MSP was the entry point for African uranium, thorium, and beryllium ores. These ores, imported for use in the nation's early atomic energy program, were tested at MSP and then shipped to other sites for processing. Traces of radioactive material were carried over the years by wind and rain to neighboring properties. From 1967 to 1979, the site was used as a U.S. Marine Corps Reserve training center.

In 1980, the site became part of the Department of Energy (DOE) Formerly Utilized Sites Remedial Action Program (FUSRAP). In February 1999, MSP was listed on the Environmental Protection Agency's National Priorities List, after uranium was detected in the stream along the site boundary. On-site groundwater is contaminated with arsenic, chromium, lead, manganese, and uranium.

Over the years, the buildings and soil of the MSP property and the soil of other nearby properties were contaminated with elevated levels of radioactive hazardous substances. A significant portion of the plant property is covered by contaminated soil that extends to depths of nearly 5 feet. During a 1948 regrading of the site, some of this contaminated soil was sent to the Middlesex Municipal Landfill and to two other properties nearby.

Excavation of radioactive material from the Middlesex Municipal Landfill was completed in 1986. The material was stored at MSP until 1998, when it was shipped to an off-site hazardous waste landfill.

Past Activities at MSP

Off-Site Contamination

- During 1980 and 1981, DOE cleaned up the site and 33 nearby properties. Approximately 58,800 cubic yards of radioactive contaminated soil was excavated and placed in two covered interim storage piles at MSP. In 1998 and 1999, the Army Corps of Engineers removed both storage piles and transported them to permitted hazardous materials landfills.

Community Health Studies and Activities

- In December 1999, ATSDR sent letters to the 5,000 homes and businesses within a 1-mile radius of the site informing residents of ATSDR's activity at the site and requesting community members to inform ATSDR of any concerns they may have about possible adverse health effects relating to MSP. ATSDR heard from more than 175 residents. A major concern was potential groundwater contamination.

- In February–April 2000, ATSDR conducted an exposure investigation to determine if off-site groundwater used as drinking water was contaminated. ATSDR sampled water from 17 residences near MSP for the contaminants found in on-site groundwater (arsenic, chromium, lead, manganese, and uranium). The water in some of the residential wells was contaminated, but ATSDR concluded that the current contamination levels would not cause adverse health effects.

Studies of the Health of Middlesex Workers

No studies of former Middlesex workers exist.

Current Activities at MSP

- **ATSDR public health assessment.** ATSDR is conducting a public health assessment to determine if people are being exposed to hazardous substances and, if so, whether that exposure is harmful and should be stopped or reduced. In 1999, ATSDR began evaluating available environmental information about the site, including groundwater, soil, and air data. This information, together with the results of the ATSDR exposure investigation, will be used to determine whether harmful exposures have occurred.

- **ATSDR health education and promotion.** ATSDR will determine its health education and promotion activities based on the findings and recommendations from the draft public health assessment and from the comments received from community residents during the public comment release period. These activities could include holding a public availability session for residents potentially impacted by MSP and developing community health education materials which may include fact sheets, educational brochures, and document summaries.

- **ATSDR health studies.** Through a cooperative agreement with ATSDR, the New Jersey Department of Health and Senior Services analyzed total cancer incidence and 11 site-specific cancer groupings (bladder, brain and central nervous system, pancreas, lung and pleura, leukemia, non-Hodgkin lymphoma, liver, bone, kidney, thyroid, and breast).

For 1979–1991, the total cancer incidence and the incidence for most site-specific cancer groups were lower that expected. The 1979–1991 incidence rate in Middlesex Borough for leukemia in males was elevated.

During a later time period (1992–1998), total cancer incidence was higher than in the earlier period. However, leukemia incidence in males was not elevated.

➢ As part of the public health assessment process, ATSDR has found workers' monitoring records indicating inhalation of radon and radioactive dust particles by workers. ATSDR and NIOSH are discussing the feasibility of a worker study.

Issues Needing Attention at MSP

Results of the public health assessment are pending.

Proposed Activities at MSP

New Activities for FY 2002–2007

No new activities are proposed at this time.

Monticello Mill Tailings Site
Monticello, Utah

Background

The Monticello Mill Tailings Site is located in the city of Monticello, in San Juan County, Utah. Initially, the site was an ore-buying station. Ore production increased sufficiently to justify mill construction in 1941. The mill produced vanadium (1942–1943), uranium-vanadium sludge (1943–1946), and uranium (1949–1960).

The now abandoned uranium processing mill contaminated soils and buildings throughout Monticello because these soils were taken from the mill site and used as fill for open lands; backfill around water, sewer, and electrical lines; and sand mix in concrete, plaster, and mortar. The total tonnage of uranium mill tailings removed from the mill site for construction purposes was never documented. However, contaminated material is estimated at 156,000 cubic yards. As a result, residents have been exposed to low levels of uranium, radium-226, radon-222, and associated radiation. A total of 449 properties are being remediated.

Past Activities at Monticello

Off-Site Contamination

➢ Hazardous substances include yellow cake (uranium oxides), black cake (vanadium oxides), and uranium. The tailings that remain on the mill site would be considered a public health hazard today if the public had access to the site. However, because access is strictly controlled, the mill site does not pose a direct threat to area residents.

Community Health Studies and Activities

➢ The Utah Cancer Registry is part of the National Cancer Institute's Surveillance, Epidemiology, and End Results (SEER) program. Utah has the lowest cancer incidence in the SEER system and the lowest overall cancer mortality rate of any state. The main reason seems to be the low smoking rates and the associated low rates of smoking-related cancers. Since becoming part of the SEER system, Utah has had an incidence rate approximately 16% below national rates, while mortality rates are approximately 28% below the national average.

➢ As part of the public health assessment published in 1997, the Agency for Toxic Substances and Disease Registry (ATSDR) reviewed available health outcome data and identified the following increased causes of death for San Juan County compared to

other Utah counties: (1) renal failure in women only, (2) breast cancer in women, and (3) cancer associated with the respiratory tract.

Studies of the Health of Monticello Workers

- Industrial hygiene surveys performed when the mill was operating reported that conditions were dusty and that workers were exposed to levels of radioactive dusts above allowable concentrations (Holaday et al., 1952; Archer et al., 1973). Because of the known exposure to workers, a urine sampling and assaying program was begun at the mill in 1956, which would have detected uranium exposure. Workers in areas with higher air dust levels, all males, were sampled weekly.

- In occupational cohort studies of uranium mill workers, excess deaths due to nonmalignant respiratory disease and cancer of the blood-forming organs other than leukemia have been reported (Archer et al., 1973; Waxweiler RJ et al., 1983).

- According to a more recent survey of health conditions among American Indian and non- Indian former uranium mill and mine workers, a majority of these workers reported respiratory diseases or symptoms which included chronic obstructive pulmonary disease, emphysema, fibrosis, persistent cough, pneumoconiosis, and silicosis.

Current Activities at Monticello

Off-Site Contamination

The Department of Energy is continuing remediation of the properties near Monticello.

Community Health Studies and Activities

- **ATSDR health studies.** As a followup to the 1997 public health assessment, ATSDR undertook a health consultation to (1) update data on leukemia, lymphoma, breast, kidney, and respiratory cancer incidence from 1943 through 1996 and analyze the 1967–1996 data, (2) update data on death due to renal failure from 1993 through 1995 and analyze the 1979–1995 data, and (3) collect and analyze incidence data on end-stage renal disease (ESRD) from 1977 through 1995. The report has not been through peer review or published yet.

- **ATSDR health studies.** As resources permit, ATSDR will continue to update and re-analyze cancer incidence, renal failure and ESRD data. Furthermore, knowing the high proportion of American Indians in Monticello and in San Juan County, adequate comparisons are being planned for the future with non-exposed populations sharing similar ethnic and tribal background and thus similar susceptibility to the development of kidney disease.

➢ **ATSDR health education and promotion.** These activities have been completed.

NIOSH Occupational Health Studies

➢ The Centers for Disease Control and Prevention's National Institute of Occupational Safety and Health (NIOSH) is conducting a follow-up study of former uranium mill workers; however, Monticello is not included because employment records could not be located. Instead, the study will focus on the Four Corners area (the point of intersection for Arizona, Colorado, New Mexico, and Utah) and will attempt to identify 500 exposed workers and 100 controls in order to conduct a cross-sectional medical survey. The outcomes of interest are pulmonary and renal effects. The University of New Mexico Medical Center will send a mobile van out to communities in this area to carry out the medical component of this study.

Issues Needing Attention at Monticello

The gaps specific to Monticello are being addressed in the ongoing studies.

Proposed Activities at Monticello

Ongoing Activities

The agencies propose to continue the previously listed projects already underway.

New Activities for FY 2002–2007

No new activities are proposed at this time.

Mound Plant
Miamisburg, Ohio

Background

The Mound Plant is a Department of Energy (DOE) production facility located in the city of Miamisburg, in Montgomery County, Ohio, 10 miles southwest of Dayton. While the research and production areas of the site once occupied 306 acres, most of Mound's DOE activities have been terminated or relocated to other DOE facilities, and parcels of the original property are being turned over to private ownership as they become available.

Mound was built in the late 1940s under the auspices of the war department. Until recently, the Mound Plant did research and development (for example, from the mid 1950s until 1985, scientists studied radioactive isotopes, such as those of uranium and thorium). The plant also manufactured components for nuclear weapons.

DOE either ended these programs or transferred them to other facilities. The one active production program still at the site is the manufacture of electric power sources, which use plutonium-238. However, much of DOE's work at the site relates to environmental cleanup.

Public health issues at the site include past exposures to both workers and residents in the community to a wide range of radioactive and chemical contaminants including polonium-210, plutonium-238, and tritium. Current exposures are to workers involved in the cleanup of the site.

Past Activities at Mound

Off-Site Contamination

- The Agency for Toxic Substances and Disease Registry (ATSDR) conducted a public health assessment of possible off-site exposures to hazardous materials released from the site and determined that the plant currently poses no apparent public health hazard. Insufficient information, however, made it impossible for ATSDR to determine whether releases of polonium or non-radioactive materials from the site during the 1950s ever posed a public health hazard.

- After being notified by ATSDR that levels of plutonium-238 were elevated in the Miami-Erie Canal and the Miamisburg Community Park, Miamisburg closed the fishing pond.

Community Health Studies and Activities

➢ An environmental health workshop was developed through a cooperative agreement with the Boston University School of Public Health to educate and help communities and healthcare providers near DOE sites evaluate the usefulness and practicality of collecting and assessing health outcome data. On May 19, 1995, a workshop for the community near the site was presented in Miamisburg.

Studies of the Health of Mound Workers

➢ A preliminary study examined the mortality of 4,697 white male Mound Plant workers through 1979. Overall, no death rate was higher than expected based on U.S. general population rates. Among men first hired between 1943 and 1945, the rates for all causes of death combined, all cancers combined, cancers of the rectum and lung, all respiratory diseases, and all injuries were higher than expected. The higher rates for all causes of death combined and lung cancer were localized among men who worked at the plant less than 2 years. Among men hired through 1959, cancer of the prostate was high among those who worked there more than 5 years.

➢ A second mortality study looked at the same group. No increase in overall mortality or site-specific cancers was noted. In a subgroup of 3,229 workers monitored for external radiation, a dose-response relationship based on small numbers of deaths was observed for lymphopoietic/hematopoietic cancers and for all leukemias.

➢ Subsequently, the mortality of 4,402 white male workers at the site was studied through 1983. Among the men initially hired during World War II, increased mortality rates, relative to the U.S. population, were reported for all causes of death combined, all cancers combined, cancer of the rectum, lung cancer, chronic rheumatic heart disease, all respiratory diseases combined, and all injuries. These results are fairly similar to the earlier study. Among the 2,181 workers monitored for polonium-210 intake during 1944–1972, no death rates were higher than expected and no positive dose-response trends were detected.

➢ **Exposure Assessment of Hazardous Waste, Decontamination and Decommissioning, Cleanup Workers (HAWW).** Feasibility studies at seven DOE sites, including the Mound site, determined that the availability of records to identify workers and their primary activities, exposures, work histories, and medical information varied significantly from site to site. The necessary information to conduct exposure assessment, hazard surveillance, or epidemiology studies of remediation workers is currently not readily available. Within sites, data systems are fragmented and data management is inconsistent in the current environment of decentralized management and increased subcontracting.

- **Study of Mortality Among Female Nuclear Workers (MAFN).** A study of female workers from 12 DOE plants, including Mound, was combined in a cohort mortality study, and risk estimates were developed for exposure to ionizing radiation or to chemical hazards. For the entire pooled cohort, mortality from mental disorders, diseases of the genitourinary system, and from ill-defined conditions was higher than expected. External ionizing radiation exposure in these workers appeared to be associated with increased relative risk for leukemia and, to a lesser degree, with increased relative risks for all cancers combined and for breast cancer.

Current Activities at Mound

Community Involvement

No ongoing community involvement activities exist.

Off-Site Contamination

No ongoing studies assessing off-site contamination exist.

Community Health Studies and Activities

A local citizens group, Miamisburg Environmental Safety and Health, is conducting a neighborhood health survey.

NIOSH Occupational Health Studies

No ongoing studies exist.

Issues Needing Attention at Mound

- Interest has been expressed in greater local involvement in studies and public health activities relating to Mound.

- There is a need to improve assessment of exposure to polonium-210 using current models that were not available during the previous cohort study.

- There is a need to assess the extent of off-site contamination from polonium-210, plutonium-238, and tritium releases.

Proposed Activities at Mound

Ongoing Activities

The agencies propose to continue the previously listed projects already underway and to initiate new ones. Such activities will be implemented only if feasible and deemed appropriate and beneficial to the community. The agencies will establish a coordinated plan, schedule, and lead organization for each new public health activity. The plan and schedule will be presented to all potential partners for their comment.

New Activities for FY 2002–2007

- **ATSDR health consultation.** ATSDR may prepare a health consultation to address historic polonium records that were unavailable during the preparation of the public health assessment. The records primarily cover the period 1950–1959 and are still unavailable.

- **ATSDR health education and promotion.** ATSDR will provide community and healthcare provider education to support the evaluation of exposure to polonium. This could include healthcare provider education and community education regarding the information from the state health department and other agencies' work.

- **NIOSH occupational health studies (2006), Mound Cohort Mortality Study (MCMS).** This will be a follow-up study of the Mound worker cohort that has experienced exposures to tritium, polonium, and plutonium in addition to external radiation. A mortality study through 1979 showed elevated lung cancer mortality in workers employed from 1943 to 1959 and a significant dose-response relationship between plutonium-238 exposure and lymphopoietic/hematopoietic cancers and leukemia. An update would allow for additional decades of followup and the use of validated bioassay information.

Nevada Test Site (NTS)

Nye County, Nevada

Background

The 1,350-square mile Nevada Test Site (NTS) is in Nye County, in southern Nevada. NTS is federally owned land and its access is restricted. In 1951, the first nuclear weapons tests on the site were conducted. It was made a permanent testing location by withdrawing the land from public access beginning in 1952. The site was created from a portion of land that the Air Force used as a bombing and gunnery range (the gunnery range is now called the Nellis Air Force Range). The combined area of NTS, the Nellis Air Force Range, and the contiguous Tonopah Test Range is approximately 5,470 square miles.

NTS was created to accelerate the development of nuclear weapons, and has an extensive history of nuclear weapons tests, with 119 atmospheric tests conducted in 1951–1958 and 809 underground tests conducted in 1961–1992. The atmospheric tests deposited radioactive fallout downwind and across the world. The underground tests left large quantities of radionuclides in the soil and groundwater.

Low-level radioactive waste has been shipped from other Department of Energy (DOE) facilities to two NTS waste site disposal locations. One disposal site opened in the late 1960s and the other in 1978. The proposed Yucca Mountain high-level radioactive waste repository is also partially located on NTS. If plans for designating NTS as a regional waste disposal center are approved, shipments of low-level radioactive wastes (more than 200,000 by some estimates) could increase significantly.

Past Activities at NTS

Off-Site Contamination

➢ In 1997, the National Cancer Institute (NCI) published estimated thyroid doses for populations of each U.S. county due to releases of iodine-131 (I-131) during atmospheric nuclear weapons testing at NTS in the 1950s and 1960s. For the entire U.S. population, the average cumulative thyroid dose was about 2 rads. The average thyroid dose in the 24 counties with the highest exposures (located in Nevada, Utah, Idaho, and Montana) ranged from 9 to 12 rads.

The National Academy of Sciences Institute of Medicine reviewed the dose reconstruction for I-131 from NTS and concluded that resources should be focused on designing an education and information program about the health consequences of

exposure to fallout from the site. The Institute of Medicine did not recommend conducting widespread thyroid screening programs.

Community Health Studies and Activities

➢ During the 1980s, scientists at several national laboratories collected all records and data pertaining to U.S. atmospheric nuclear weapons testing. This information is now available to the public at the DOE Coordination and Information Center in Las Vegas.

A dosimetric evaluation of areas in the region was developed from this data. The study was characterized by community/locale and age/occupation. The study found that residents in southwest Utah, closest to NTS, received the highest exposures (whole body doses of less than 10 rems), but that residents of urban northern areas received a higher mean dose. Subsequent epidemiologic studies used this methodology and the models and data to estimate doses for certain cohorts and populations. The off-site Radiation Exposure Review Project established exposures from NTS fallout.

➢ A number of studies have examined the possibility of adverse health effects from radioactive fallout to people living near NTS; these studies have usually focused on thyroid disease and leukemia in children downwind from the site. Early studies of thyroid diseases found no association between occurrence of disease and living near the site. However, a 1993 study that included calculated thyroid doses reported a statistically significant dose-response trend of increased thyroid neoplasms with increased radiation dose. The relative risks of thyroid cancer for higher dose levels were elevated, but were not statistically significant.

Studies of cancer and leukemia have generally found an excess of leukemias considered radiogenic. A 1990 case-control study of leukemia deaths in Utah, found a positive dose-response relationship for acute leukemias (acute lymphocytic leukemia in particular) in persons less than 20 years old. The study found a weak overall relationship. However, the excess was confined primarily to a single, sparsely populated county.

Studies of the Health of Workers

➢ **Prevention of Stress and Health Consequences of Downsizing (STDN).** The effects of downsizing on organizational climate, worker health, and performance were studied at several DOE sites, including NTS. Data gathering included interviews, workplace observations, employee discussion groups, an employee survey distributed to more than 10,500 employees, and a historical record review. Researchers identified opportunities to reduce job stress that could lead to improved employee health and organizational well-being. Suggested intervention strategies were proposed for further research.

Current Activities at NTS

Community Involvement

In 1981, the Community Radiation Monitoring Program began. The program now has a Citizens Advisory Board which meets regularly.

Off-Site Contamination

A milk surveillance network and sampling of wells supplying drinking water have been implemented.

- **NCEH dose assessment (multi-site dose calculator).** NCEH is developing an Internet tool for people to estimate the doses they may have received from historic releases of I-131 from the Hanford Nuclear Reservation and then add those doses to ones estimated by the National Cancer Institute for I-131 in fallout from nuclear weapons testing at NTS. The Oak Ridge Reservation, the Idaho National Engineering and Environmental Laboratory, and the Savannah River Site have also historically released I-131 to the environment. NCEH is considering developing an Internet tool for people to estimate their total historic I-131 doses from all or part of these sites, as appropriate. Summing doses for radionuclides other than I-131 and for sites not listed above also may be considered, if appropriate.

- **ATSDR health consultation.** No consultations are planned at this time.

- **ATSDR health education and promotion.** ATSDR, in collaboration with NCEH and NIOSH, will implement a community health education and health communication strategy for the communities around the NTS. The agencies will work with health officials and community groups around the site to identify the community's needs for information and education, and will develop a comprehensive health education outreach program based on that information.

- **ATSDR health studies.** ATSDR continues to participates in meetings concerning NTS.

Community Health Studies and Activities

Nye County, working with representatives from 10 county governments, and the University of Nevada at Las Vegas, has completed a first draft of the Nevada Baseline Rural Health Assessment Research Proposal, a Baseline Radiation Health Study Bibliography, and initiated organizing an independent Nevada Health Study Advisory Group.

NIOSH Occupational Health Studies

No ongoing studies exist.

DOE Epidemiologic Surveillance of Current Workers

DOE's epidemiologic surveillance assesses the overall health of the current DOE workforce at 14 DOE sites, including NTS. The goal is to identify groups of workers that may be at increased risk for occupation-related injury and illness.

DOE Former Workers Medical Surveillance Program

The first phase of the DOE Medical Surveillance for Former Workers at NTS reviewed available information that will help determine whether former workers might develop health problems due to their employment at the site. The focus is on construction workers in underground and excavation work and re-entry workers who were employed at NTS from 1951 to 1992. About 15,000 workers who were represented by six construction trade unions were identified for the cohort study. Exposure information and health data are being collected, and the former workers are being contacted.

In the second phase of the study, Boston University investigators will determine which workers might possibly be at significant risk for health problems related to their exposure and those workers will be offered an opportunity to participate in a free medical screening program.

Issues Needing Attention at NTS

Gaps in understanding of health effects to workers and community members, including special populations such as Native Americans, need to be addressed.

Proposed Activities at NTS

Ongoing Activities

The agencies propose to continue the previously listed projects already underway and to initiate new ones, if feasible and beneficial to the community. The agencies will establish a coordinated plan, schedule, and lead organization for each new public health activity. The plan and schedule will be presented to all potential partners for their comment including local communities and their governments, appropriate agencies of the State of Nevada, and the NTS Citizens Advisory Board.

New Activities for FY 2002–2007

NIOSH occupational health studies (2003–2007), Nevada Test Site Mortality Study (NCMS). An occupational analytical epidemiology study has not be completed at this site. A preliminary record review by NIOSH determined that a study was feasible. The study will require the assembly of the study cohort members along with their work histories and the subsequent linkage to exposure records. The study is expected to take at least 5 years to complete due to the data collection and assembly that will be required.

Activities for Which the Funding Source is External to DOE and HHS Memorandum of Understanding

A focused program of public information and education about the consequences of the NTS fallout will be developed in coordination with the State of Nevada and Health Study Advisory Groups. The following activities address fallout from NTS:

- The cohort of former Utah schoolchildren who were previously evaluated for thyroid disease in relation to fallout exposures from the Nevada test site will be followed up for the second time.

- The Centers for Disease Control and Prevention's (CDC's) National Center for Environmental Health (NCEH) is assessing the feasibility of conducting a nationwide comprehensive assessment of the health consequences of nuclear weapons tests. General and specific high-risk populations will be considered.

- NCEH will make available CDC communication and information dissemination networks, if needed, to help the National Cancer Institute implement the public health outreach recommendations contained in the report prepared by the National Academy of Sciences and Institute of Medicine on the effects of NTS-related radioactive iodine exposures to people across the United States.

Oak Ridge Reservation (ORR)
Oak Ridge, Tennessee

Background

The Oak Ridge Reservation (ORR) occupies approximately 37,000 acres of land in Anderson and Roane Counties, in east central Tennessee. Most of the reservation is within the limits of the city of Oak Ridge. The federal government established ORR in 1942 as part of the Manhattan Project, the World War II effort to build the atomic bomb.

The three major installations on ORR are the Y-12 weapons plant, the East Tennessee Technology Park (formerly known as the K-25 site), and the Oak Ridge National Laboratory (formerly known as the X-10 site). These installations occupy about 30% of the property, the remainder, which was never used for nuclear weapons production, research processes, or waste management, being a National Environmental Research Park.

In the early years, ORR produced plutonium and enriched uranium. After the war, the installation's role broadened widely to include a variety of nuclear research and production projects vital to national security. In recent years, the facilities and expertise focused on the interest of the national defense have been downsized. Currently, missions include environmental restoration; decontamination and decommissioning; waste management, research and development related to energy; technology transfer; government and industry partnerships; and national security programs.

Operations at ORR have left a legacy of radioactive and chemical waste which have contaminated soil, groundwater, and surface water both on and off the reservation. Old waste sites occupy 5% to 10% of the reservation and most of them lack engineered containment structures.

Past Activities at ORR

Off-Site Contamination

- In 1983 the Tennessee Department of Health and Environment and the Centers for Disease Control and Prevention's (CDC's) National Center for Environmental Health (NCEH) conducted a pilot survey in Oak Ridge in response to community concerns about mercury contamination in the East Fork Poplar Creek flood plain and the sewer line beltway. The pilot survey concluded that residents and workers in Oak Ridge are not likely to be at increased risk for having significantly high mercury levels. Mercury concentrations in hair and urine samples were below levels associated with known health effects.

➢ In 1992 an Oak Ridge physician requested the Agency for Toxic Substances and Disease Registry (ATSDR) to review clinical data and medical histories of 45 patients in the Oak Ridge area. ATSDR and the Tennessee Department of Health reviewed the data and concluded that the case series referred by the physician did not provide sufficient evidence to associate low levels of metals with the diseases presented in the physician's patients. In addition, Howard Frumkin, of the Emory University School of Public Health, conducted individual clinical evaluations of these 45 patients and did not report any hazardous substance exposure to public health agencies.

➢ Additional studies were conducted on hazardous substances in East Fork Poplar Creek. Following are some of the conclusions of a 1993 ATSDR health consultation.

- Soil and sediments in certain locations along the East Fork Poplar Creek flood plain are contaminated with levels of mercury that pose a public health concern.

- Fish in the creek contain levels of mercury and polychlorinated biphenyls (PCBs) that pose a moderately increased risk of adverse health effects to people who eat fish frequently over long periods of time. However, the state of Tennessee has posted "no fishing" signs and the creek is not normally used as a source for fish.

- Although shallow groundwater along the East Fork Poplar Creek flood plain contains metals at levels of public health concern, this water is not used for drinking or other domestic purposes.

➢ In 1995 the ATSDR Science Panel Meeting on the bioavailability of mercury in soil was held to identify methods and strategies that allow health assessors to develop data-supported, site-specific estimates of the bioavailability of inorganic mercury and other metals (arsenic and lead) from soils. The panel consisted of private consultants and academicians internationally known for their metal bioavailability research and experts from ATSDR, the Centers for Disease Control and Prevention's National Center for Environmental Health Science, and the Environmental Protection Agency. ATSDR used information obtained from the panel meetings to evaluate the East Fork Popular Creek cleanup level. The findings of the science panel also were used in characterization and evaluation of other waste sites with mercury in the soil.

➢ A 1995 ATSDR health consultation concluded that the East Fork Poplar Creek flood plain soil cleanup level of 400 milligrams per kilogram (mg/kg) for mercury is protective of public health and will pose no health threat to children or adults. In 1996, the Department of Energy (DOE) cleaned up all areas along the East Fork Poplar Creek flood plain where the soil was contaminated with mercury at levels above 400 mg/kg.

➢ A 1996 ATSDR health consultation on the Watts Bar Reservoir reported the following conclusions:

- Fish in the reservoir contain PCBs, and frequent and long-term ingestion of these fish poses a possible moderately increased risk of cancer. Frequent and long-term ingestion may also increase the possibility of developmental effects in infants whose mothers consume fish regularly during gestation and while nursing.

- Current levels of contaminants in the surface water and sediment of the reservoir were not at levels of public health concern, and the reservoir was determined to be safe for swimming, skiing, boating, and other recreational purposes. Water from the municipal water systems was determined safe to drink.

- Public health would be protected by DOE's remedial actions, which included maintaining the fish consumption advisories; continuing environmental monitoring; implementing institutional controls to prevent disturbance, resuspension, removal, or disposal of contaminated sediment; and providing community and health professional education on PCB contamination.

➢ A 1997 ATSDR exposure investigation on the Watts Bar Reservoir reached the following conclusions:

- The serum PCB levels and blood mercury levels in participants in the investigation (people who consumed moderate to large amounts of fish or turtles from the reservoir) are very similar to levels found in the general population. Only 5 of the 116 people tested (4%) had PCB levels higher than 20 micrograms per liter (µg/L), or 20 parts per billion, which is elevated.

- The test results indicate that serum PCBs levels and blood mercury levels in the exposed investigation participants are very similar to levels found in the general population. The PBC and mercury levels were less than ATSDR health officials expected for people who consumed moderate to large amounts of certain fish or turtles from the Watts Bar Reservoir. ATSDR health officials believe that health effects are not likely for the PCBs or mercury levels seen in the exposed investigation participants.

- Of the five participants who exceeded 20 µg/L, four had levels of 20–30 µg/L. Only one participant had a serum PCB level of 103.8 µg/L, which is higher than the general population distribution. Only one participant had a total blood mercury level higher than 10 µg/L, which is elevated. The remaining participants had mercury blood levels that ranged up to 10 µg/L, as might be expected to be found in the general population.

➢ Additional studies were conducted for the East Tennessee Technology Park. A 1997 Governor of Tennessee's Independent Panel Report on the DOE Toxic Substances

Control Act (TSCA) Incinerator at the East Tennessee Technology Park concluded that the TSCA incinerator facility and operating conditions were in harmony with its permit and that the facility had experienced few operating violations. The amount of waste actually burned is a small fraction of the volume that the incinerator was designed for and permitted to process. The highest concentrations measured by the site monitors were but a small fraction of the permissible levels, and most pollutants that were measured were not primarily from the TSCA incinerator.

Community Health Studies and Activities

➢ In 1991, the Tennessee Department of Health entered into an agreement with DOE for an Oak Ridge health study project. The project consisted of two phases. Phase I was a dose reconstruction feasibility study. Phase II reconstructed releases of, and potential exposures to the most significant contaminants as identified in Phase I.

Phase I evaluated all past releases of hazardous substances and operations at the Oak Ridge Reservation. The object of the study was to determine the quantity, quality, and potential usefulness of the available information and data on these past releases and subsequent exposure pathways. With this information, preliminary screening analyses were performed to identify priority hazardous substances of public health concern and determine the feasibility of conducting dose reconstruction studies that would reconstruct these releases and estimate exposure doses. The result of Phase I of the study was the determination that radioactive iodine, mercury, polychlorinated biphenyls (PCBs), and radionuclides released to the White Oak Creek needed to have further study.

Phase II of the study reconstructed past releases of radioactive iodine, mercury, PCBs, radionuclides from White Oak Creek, and uranium. Phase II also estimated that past exposure of these hazardous substances to off-site populations. Results from Phase II showed the following:

- Radioactive iodine releases were associated with radioactive lanthanum processing at X-10 from 1944 through 1956. Results indicate that children born in the area in the early 1950s who drank backyard cow's or goat's milk had an increased risk of developing thyroid cancer. Within a 25-mile radius of Oak Ridge, it is likely that these children had an increased risk of more than 1 in 10,000 of developing thyroid cancer.

- The study evaluated mercury releases associated with lithium separation and enrichment operations at the Y-12 plant from 1955 through 1963. Results indicate that during the years mercury releases were highest (mid 1950s to early 1960s), individuals may have engaged in activities that resulted in their receiving annual averages doses of mercury that exceeded the reference dose. (The reference dose for a substance is an

estimate of the largest amount of a substance that a person can take in on a daily basis over their lifetime without experiencing adverse health effects.)

- Additional studies were conducted on PCBs in fish from the East Fork Poplar Creek, Clinch River, and the Watts Bar Reservoir. Preliminary results indicated that individuals who ate a large amount of fish from these waters may have received doses that exceeded the reference dose for PCBs.

- Radionuclides associated with various chemical separation activities at X-10 from 1943 through the 1960s were released via White Oak Creek. Eight radionuclides deemed more likely to carry significant risks were studied. The results indicate that the White Oak Creek releases caused small increases in radiation dose in consumers of fish from the Clinch River near the mouth of White Oak Creek. However, less than 1 excess cancer case is expected from 50 years of fish consumption.

- Uranium was released from various large-scale uranium operations, primarily uranium processing and machining operations at the Y-12 plant from 1944 to 1988 and uranium enrichment operations at the K-25 and S-50 plants. Because uranium was not initially given high priority as a contaminant of concern, a level II screening assessment for all uranium releases was performed. Preliminary screening indices are slightly below the decision guide of 1 chance in 10,000, indicating that more work may be needed to better characterize uranium releases and possible heath risks.

➢ The Tennessee Department of Health conducted two health statistics reviews– one in 1992 to compare cancer incidence rates (1988–1990), and one in 1994, to compare mortality rates (1980–1992) of counties surrounding ORR to rates for the rest of the state. The reviews concluded that some rates were elevated and others were low compared to the state rates and that no patterns were identified as related to the site.

➢ The ATSDR health education program informed local residents and physicians of the health effects associated with eating PCB contaminated fish in the Watts Bar Reservoir. A physician and health professional education meeting was sponsored in Oak Ridge for healthcare providers near the Watts Bar Reservoir. Two ATSDR publications, “Polychlorinated Biphenyls” and “Taking an Exposure History,” were sent to area health specialists. An instructive brochure on the Tennessee Department of Environment and Conservation fish consumption advisories for the Watts Bar Reservoir was also issued.

➢ ATSDR conducted a physician education program to provide information regarding the health impacts of possible cyanide intoxication and to assist community healthcare providers in responding to health concerns expressed by employees working at the East Tennessee Technology Park (ETTP). An environmental health education session for physicians was held at the Methodist Medical Center in Oak Ridge. ETTP employees

and physicians received copies of the ATSDR publication on cyanide toxicity, the final health hazard evaluation by the Centers for Disease Control and Prevention's (CDC's) National Institute of Occupational Safety and Health, and the ATSDR public health statement for cyanide. ATSDR instituted a system through which local physicians could refer patients to the Association of Occupational and Environmental Clinics (AOEC).

➢ According to the 1998 CDC health investigation of the Scarboro community, the results of the self-reporting health survey indicated elevated rates of asthma and wheezing. The asthma rate was 13% among children in Scarboro, compared to national estimates of 7% among all children aged 0–18 years, and 9% among African American children aged 0–18 years, which is less that the 14.5% Chicago rate. The wheezing rate among children in Scarboro was 35%, compared to international estimates of 1.6% to 36.8%.

No statistically significant association was found between exposure to common environmental triggers of asthma (e.g., tobacco smoke, pests, unvented gas stoves, and dogs or cats in the home) or potential occupational exposures (e.g., living with an adult who works at ORR or living with an adult who works with dust and fumes and brings exposed clothes home) and asthma or wheezing illness.

The physical examinations of 23 Scarboro children who were identified in the survey as possibly having asthma indicated that all were generally healthy and no urgent health problems were identified. Only one child had a lower respiratory illness, and none were wheezing at the time of the physical examination.

Studies of the Health of Oak Ridge Workers

Researchers at CDC's National Institute for Occupational Safety and Health (NIOSH) and various collaborators including the Oak Ridge Associated Universities, the University of North Carolina, and the University of Michigan have conducted numerous studies on exposures received at ORR and the relationship to health effects among workers at ORR. Study findings to date include the following:

➢ The Oak Ridge National Laboratory (X-10) has been the subject of long-term epidemiologic study. A mortality analysis of 8,375 white males through 1977 found no cause of death that was higher than expected based on the U.S. general population. However, leukemia mortality was related to length of employment in engineering and maintenance jobs. A follow-up study reported that the death rate from leukemia through 1984 was greater than the U.S. rate, particularly among workers monitored for internal radiation contamination.

For all cancers combined, except for leukemia, a positive trend was reported by level of cumulative external dose. In the most recent study of deaths through 1990, none of the rates for the four causes of death reported, all causes of death combined, all cancers combined, lung cancer, and leukemia, were higher than the corresponding U.S. rates.

A recent study of deaths through 1990 reported that radiation doses received after age 45 strongly predict the combined mortality rate for all cancers.

➢ The first study of Y-12 workers included 18,869 white males who ever worked at the plant and mortality through 1974 was identified. The second study was restricted to 6,781 men who worked at least 30 days with mortality through 1979. A third study was expanded to include 10,597 nonwhite workers and females with deaths through 1990. The death rate from lung cancer was higher than the U.S. rate in the most recent two studies. Analysis of deaths through 1979 did not confirm positive trends for any cause of death with either external or internal exposure to ionizing radiation although a weak trend was observed for lung cancer.

➢ Between 1953 and 1963 the Y-12 Plant used metallic mercury to produce large quantities of enriched lithium. There were 5,663 workers categorized by exposure based on results of urinalysis data. Analysis of deaths through 1978 revealed no differences in the mortality patterns for mercury-exposed workers as a whole, workers with the highest mercury exposures, and workers employed more than a year in a mercury process. A total of 502 mercury workers were also involved in a clinical neurology study. Clinical measurements revealed some deficiencies in neurological function, particularly among those workers with the highest exposures, but these were not associated with the duration of exposure. A follow-up study of 219 of the original subjects in the 1990s revealed that some neurologic effects were still detectable.

➢ During the early operation of the Y-12 plant from 1942 to 1947, a group of 694 male workers was exposed to phosgene gas on a chronic basis and 106 males and 91 females received acute exposures. A control group of 9,280 workers who also worked at Y-12 during the same era, but who did not have phosgene exposure, was also described. All groups were followed through the end of 1978 with particular interest in respiratory diseases and lung cancer. There was no evidence for increased mortality from respiratory diseases in this group.

➢ Studies of workers at K-25 found that white males had high rates relative to the U.S. population for all causes of death; cancer of the respiratory system, particularly lung cancer; bone cancer; mental disorders; all respiratory diseases, particularly pneumonia symptoms; senility and ill-defined conditions; all external causes of death, particularly accidents and specifically motor vehicle accidents. White females had a high rate for symptoms of senility and ill-defined conditions.

➢ Powdered nickel was used at K-25 to produce the barrier material that separates and enriches uranium. Death rates for 814 nickel workers who made the barriers were compared to 1,600 controls. No differences in the death rates for the exposed and non-exposed workers by cause of death through 1972 were detected. A later study compared the mortality of the 814 nickel workers through 1977 and 7,552 non-exposed workers.

There were no causes of death with a rate higher than the U.S. rate and no differences between exposed and non-exposed workers.

➢ Epoxy resins and solvents were common exposures among K-25 gas centrifuge workers. In Phase I of a study of centrifuge workers, 263 workers with the most exposure were compared with 271 workers with no exposure at the plant during the same period. The centrifuge process workers reported five bladder cancers versus none reported by the non-centrifuge group. The standardized incidence rate ratio was 7.8 for process workers versus comparison workers. In Phase II of the study, a larger group, who had lower levels of exposure to the centrifuge process, was studied. One additional case was found in a centrifuge worker and two additional cases were found in maintenance workers who were assigned to work in centrifuge areas. An equal number of cases of bladder cancer were found in the comparison group in Phase II. A specific cause for the increase in bladder cancer was not identified.

➢ Several studies have considered all ORR workers, the most recent one updated mortality through 1984. Mortality from all causes of death combined and all cancers combined were similar to overall U.S. rates. There were substantial differences in death rates among workers at the various ORR plants, particularly the rates for lung cancer, leukemia and other lymphatic cancer. Within the second study, data for 28,374 workers at X-10 and Y-12 were analyzed and positive trends were reported with increasing external radiation dose for all causes of death combined and all cancers combined.

➢ Three studies of brain cancer across the four ORR facilities have been published. The exposure analysis of 26 chemicals found that none were positively associated with brain cancer. No positive trends for brain cancer were found with increasing external radiation dose and internal dose as measured by the lung dose. Although workers with brain cancer were more likely than other workers to have worked at ORR more than 20 years, there was no trend of increasing cancer with the number of years worked.

➢ Mortality data through 1974 and through 1989 were analyzed for 1,059 white male welders at ORR. No death rates were higher than the U.S. rate through 1974. When deaths through 1989 were considered, welders had higher rates of lung cancer, cancer of the prostate, and gastric ulcers. The risk of each cause was different among the facilities. The risk of lung cancer among welders exposed to nickel oxides did not differ from non-exposed welders.

➢ A multi-site study of multiple myeloma deaths included workers from X-10. Although the death rate was not higher than expected, higher risks were encountered by workers whose radiation exposures occurred after age 45.

➢ A study of the potential association between paternal exposure to ionizing radiation and risk of childhood cancer found no link between leukemia and paternal employment at

ORR. Children whose fathers worked at the Hanford Nuclear Reservation were more likely to get central nervous system (CNS) cancer than children whose fathers worked at other sites, including ORR, but this finding was based on small numbers and was not statistically significant.

- A NIOSH health hazard evaluation, requested by K-25 site employees, investigated possible worker exposure to cyanides. The evaluation indicated that employees are not occupationally exposed to hydrogen cyanide, cyanide salts, or a wide variety of other compounds that contain the cyanide ion.

- The Oak Ridge National Laboratory, sponsored by a NIOSH grant, investigated statistical estimation of dose from daily and weekly dosimetry data for ORR radiation workers included in previous epidemiologic studies. The study found that differences between the two methods were substantial, and recommended methods of reducing uncertainty for some estimates.

- The Oak Ridge Associated Universities, under a NIOSH grant, developed a project at ORR to develop a system for prioritizing industrial hygiene and medical surveillance efforts. The Worker Exposure Surveillance System (WESS) was designed for easy data merger with traditional occupational health systems using environmental level analyses, occupational titles, and area descriptors.

- **Exposure History for the Construction Trades (WHEP).** The University of Cincinnati, under a NIOSH grant, created an exposure history for the construction trades at ORR, which was aimed at improving worker recall of complex occupational exposures across a large number of short-term workplace assignments. New techniques were used to establish guidelines and formats for personal work histories. This study has recently been completed and the results will be disseminated in 2002.

- **Exposure Assessment of Hazardous Waste, Decontamination and Decommissioning, Cleanup Workers (HAWW).** Feasibility studies at seven DOE sites, including ORR, determined that the availability of records to identify workers and their primary activities, exposures, work histories, and medical information varied significantly from site to site. The necessary information to conduct exposure assessment, hazard surveillance, or epidemiology studies of remediation workers is currently not readily available. Within sites, data systems are fragmented and data management is inconsistent in the current environment of decentralized management and increased subcontracting.

- **Prevention of Stress and Health Consequences of Downsizing (STDN).** The effects of downsizing on organizational climate, worker health, and performance were studied at several DOE sites, including ORR. Data gathering included interviews, workplace observations, employee discussion groups, an employee survey distributed to more than 10,500 employees, and a historical record review. Researchers identified opportunities

to reduce job stress that could lead to improved employee health and organizational well-being. Suggested intervention strategies were proposed for further research.

➢ **Study of Mortality among Female Nuclear Workers (MAFN).** A study of female workers from 12 DOE plants, including ORR, was combined in a cohort mortality study, and risk estimates were developed for exposure to ionizing radiation or to chemical hazards. For the entire pooled cohort, mortality from mental disorders, diseases of the genitourinary system, and from ill-defined conditions was higher than expected. External ionizing radiation exposure in these workers appeared to be associated with increased relative risk for leukemia and, to a lesser degree, with increased relative risks for all cancers combined and for breast cancer.

Current Activities at ORR

Off-Site Contamination

➢ **ATSDR public health assessment.** The public health assessment will (1) identify people exposed at levels of health concern, (2) identify increased rates of health outcomes, (3) address community health concerns, and (4) recommend follow-up public health actions or studies. To avoid duplicating efforts, ATSDR will use the data and information collected by the Tennessee Department of Health during their environmental dose reconstruction project.

Community Studies and Activities

➢ **Oak Ridge Health Effects Subcommittee.** The subcommittee is a vehicle for community members, local interest groups, and state and federal agencies to work collectively and make informed recommendations regarding the public health agenda for ORR. This forum will enable state and federal agencies to interact with local interest groups. The agencies will have the opportunity to present to community members the results of previous studies, analyses of exposure pathways, results of the health statistics review, and the criteria used to select and conduct appropriate public health activities.

Community members will help prioritize public health issues and community concerns and provide input into the choices to be made between current and historical exposures and different public health activities. Discussion between the groups will provide an opportunity for education and collaboration. Local interest groups and state and federal agencies can work together to develop the health agenda for ORR. The agencies will address the public health concerns of the community and discuss their findings and any recommendations for further studies or additional public health actions.

The following topics have been suggested for discussion in conjunction with the public forum the: (1) procedures for establishing medical cause and effect, (2) limitations of

epidemiology, and (3) difficulties of dealing with residential or other ill-defined clusters, including small sample sizes.

➢ **ATSDR needs assessment for health education and promotion.** In FY 2000, the Association of Occupational and Environmental Clinics (AOEC) began a community needs assessment at ORR through a cooperative agreement with ATSDR. The needs assessment is the first step in the process to implement a site-specific environmental health intervention (EHI) project at ORR.

➢ A continuing need to address environmental justice issues exists. DOE's Oak Ridge Operations Office maintains a formal and active Environmental Justice Plan consistent with Executive Order 12898, to address environmental justice in minority populations and low-income populations, at and around ORR. (The Executive Order requires federal agencies to make achieving environmental justice a part of their mission.) The University of Tennessee is also partnering with numerous East Tennessee urban and rural grassroots community groups, including those with special interest in ORR activities, to understand and address the core problems facing low- and moderate-income communities.

➢ **ATSDR environmental justice.** ATSDR's Office of Urban Affairs will ensure that ATSDR activities consider the special needs of minority populations and low-income populations.

NIOSH Occupational Health Studies

➢ **Multiple Myeloma Case-control (K25K).** NIOSH's multiple myeloma case-control study at ORR's K-25 facility will help understand the relationship between multiple myeloma and different types of radiation exposure. A previous study at the University of North Carolina examined the relationship between multiple myeloma and exposures to external radiation and chemicals. The current NIOSH study will look at the relationship between multiple myeloma and exposures to internal radiation and chemicals.

➢ **Cohort Mortality Study of DOE Chemical Laboratory Workers (CLWS).** Limited previous studies outside the DOE complex suggest an increased risk of cancer in chemical laboratory workers. In this study, workers potentially exposed to groups of chemicals and ionizing radiation will be assessed and their relationship to mortality patterns will be investigated.

➢ **Multi-site Case-control Study of Lung Cancer and External Ionizing Radiation (LUNG).** This ongoing NIOSH case-control study combines worker information from multiple sites, including ORR, to clarify the relationship between lung cancer and external radiation exposure.

➢ **Multi-site Leukemia Case-control Study (LCCS).** This ongoing NIOSH case-control

study combines worker information from multiple sites, including ORR, to explore the relationship between external radiation and leukemia risk among 250 workers with leukemia compared to similar workers without leukemia.

DOE Epidemiologic Surveillance of Current Workers

DOE's epidemiologic surveillance assesses the overall health of the *current* DOE work force at 14 DOE sites, including ORR Y-12 weapons plant, Oak Ridge National Laboratory (X- 10), and the East Tennessee Technology Park (ETTP) (formerly ORR K-25 site). The goal is to identify groups of workers that may be at increased risk for occupation-related injury and illness.

DOE Occupational Health Studies under DOE Former Worker Program

➢ An independent panel of nationally recognized occupational health physicians is conducting individual medical evaluations to assess occupational health complaints and symptoms of 53 current and former Lockheed Martin Energy Systems workers at ETTP. These medical evaluations include reviews of prior health studies; visits to workers' workplaces and surroundings; work history interviews with individual workers; reviews of worker medical records; physical examinations; and specialized follow-up inquiries and testing.

➢ The DOE Beryllium Worker Medical Surveillance Program, which includes an intensive, coordinated health-risk communication effort, is designed to detect and diagnose chronic beryllium disease (CBD) among current and former workers exposed to beryllium throughout the DOE complex, including ORR. Information from this program is used to improve and evaluate worker protection and control measures, to monitor trends in CBD frequency, and to strengthen work planning to minimize worker exposures.

➢ DOE's Former Worker Program is a pilot program designed to provide medical surveillance for selected former DOE workers at risk of work-related illness as a result of exposures while working at DOE facilities. The following projects are underway at ORR:

- The former construction workers project is led by Dr. Eula Bingham of the University of Cincinnati in cooperation with the United Brotherhood of Carpenters Health and Safety Fund, the Center to Protect Workers' Rights, and Duke University Medical Center. The Phase I assessment identified approximately 800 former construction workers. Phase II will focus on medical screening of workers exposed to asbestos, beryllium, noise, silica, solvents, and heavy metals.

- The project involving former production workers from the Oak Ridge K-25, Paducah,

and Portsmouth gaseous diffusion plants is led by Dr. Steven Markowitz of Queens College, City University of New York, and Mr. Robert Wages of the Oil, Chemical, and Atomic Workers International Union, in cooperation with the University of Massachusetts at Lowell. The Phase I assessment identified approximately 1,260 former production workers as potentially at high risk. Phase II will focus on medical screening of workers exposed to asbestos, beryllium, bladder carcinogens, chlorinated solvents, fluorine compounds, nickel, noise, silica, uranium, welding fumes, and heavy metals.

➢ DOE plans to expand the Former Worker Medical Surveillance Program to current workers and additional former workers at the three gaseous diffusion plants.

Issues Needing Attention at ORR

➢ The process for evaluating the necessity for and criteria for possible clinical intervention in the community needs attention.

➢ The knowledge of possible soil contamination levels in residential areas closest to the ORR plants needs attention.

➢ Current monitoring systems and atmospheric dispersion models should be analyzed to determine if they are appropriate for the materials in use and the pathways.

Proposed Activities at ORR

Ongoing Activities

The agencies propose to continue the previously mentioned projects already underway and to initiate new ones to address the health conditions of the Oak Ridge area community members. New activities will be implemented only if feasible and deemed appropriate and beneficial to the community.

New Activities for FY 2002–2007

➢ **ATSDR environmental health intervention.** AOEC and ATSDR will continue to work with representatives from the various agencies, community members, and Health Effects subcommittee members to develop and implement the Environmental Health Intervention (EHI) Project at ORR. This project promotes a community-driven approach to integrating environmental medicine, health education, and capacity-building to help clarify an individual's exposure status and evaluate associated health concerns.

This project will also facilitate an individual's access to environmental health services

and strengthen the ability of the local public health system to provide followups for health concerns. Site-specific EHI projects include a community health needs assessment, clinical evaluations, environmental health education, program evaluation, risk communication, and clinical specialty referrals implemented in partnership with the affected communities and the AOEC.

- **ATSDR health studies activities.** Currently, ATSDR is working with the Oak Ridge HES to review the existing Oak Ridge literature and to provide basic epidemiologic training to members of the Subcommittee, who are considering the feasibility of conducting epidemiologic studies on some of the exposures identified in the Oak Ridge area.

- **ATSDR Oak Ridge health study.** ATSDR is providing the Tennessee Department of Health a summary of the external peer review comments on dose reconstruction studies for cesium, iodine-131, mercury, and PCB. The feasibility of a follow-up health activity is contingent on the completion of the public health assessment. ATSDR anticipates that the members of the ORR Health Effects Subcommittee may recommend a health study.

- **NIOSH occupational health studies (2002–2006), K-25 Cohort Mortality Study Update (K25C).** The study will update on all cause cohort mortality study at the K-25 gaseous diffusion plant. The more than 40,000 workers employed at the site between 1942 and 1987 will be followed to ascertain cause of death in workers who died through December 31, 2001. Occupational exposures that will be evaluated include external and internal radiation as well as chemicals used in the K25 facility processes.

Paducah Gaseous Diffusion Plant (PGDP)
Paducah, Kentucky

Background

The Paducah Gaseous Diffusion Plant (PGDP) is an uranium enrichment facility covering approximately 1,350 acres in western McCracken County, Kentucky. It is approximately 10 miles west of Paducah, and about 3 miles south of the Ohio River. PGDP began operating in 1952. Previously, the site and surrounding areas were used as a World War II-era ordnance facility known as the Kentucky Ordnance Works. Currently, the plant is leased and operated by the United States Enrichment Corporation (USEC) to produce low-enriched commercial power reactor fuel. The Department of Energy (DOE) owns the site and retains responsibility for environmental remediation activities and waste generated prior to July 1, 1993, when USEC assumed responsibility.

The entire reservation covers 3,424 acres, with approximately 750 acres in a fenced security area and an uninhabited buffer zone surrounding the fenced area. Beyond the DOE-owned buffer zone is an extensive wildlife management area of 2,100 acres deeded or leased to the Commonwealth of Kentucky.

PGDP performs the first step in the uranium enrichment process, enriching uranium-235 in a physical separation process. After enrichment at PGDP, the uranium is further enriched at another DOE gaseous diffusion plant. In the future, all enrichment will be done at PGDP.

PGDP has extensive support facilities, including a steam plant, four major electrical switch yards, four sets of cooling towers, a building for chemical cleaning and decontamination, a water treatment plant, maintenance facilities, and laboratory facilities. The site also includes a raw-water treatment plant, a residential landfill, an inert landfill, a former sanitary landfill, and two industrial treatment lagoons.

PGDP has been chosen as one of two uranium conversion facilities. It will convert depleted uranium hexafluoride (the tails from the enrichment process) to a more stable form, uranium oxide or uranium metal. DOE is currently reviewing proposals for the facility.

Past Activities at PGDP

Off-Site Contamination

➢ In August 1988, DOE found technetium-99 (TC-99) in an off-site drinking water well north of PGDP. Trichloroethylene (TCE) has also been detected in nearby private wells and on and off-site monitoring wells. The contaminated residential wells are no longer used.

Approximately 1,400 people obtain drinking water from public and private wells within 4 miles of the plant.

➢ Plant operations have generated hazardous, nonhazardous, and radioactive wastes, including chromium, heavy metals, polychlorinated biphenyls (PCBs), Tc-99, TCE, and uranium (multiple isotopes). DOE has detected PCBs in on-site surface water and downstream of the plant in Big Bayou Creek and in Little Bayou Creek. These creeks pass through the West Kentucky Wildlife Management Area, which is adjacent to the plant and to private property. Access to Little Bayou Creek is partially restricted, but access to Big Bayou Creek is not and Big Bayou Creek is occasionally used for fishing. In 1989, the commonwealth of Kentucky's Division of Water warned against eating fish caught in Little Bayou Creek and in several of the ponds in the wildlife management area. Contamination in the ponds result from the former Kentucky Ordnance Works which operated on the property during World War II.

HHS Community Health Studies and Activities

No HHS community health studies or activities exist at the site.

Studies of the Health of PGDP Workers

No completed health studies of workers at PGDP exist. Two new studies are proposed for FY 2002.

Current Activities at PGDP

Community Involvement

➢ **ATSDR community involvement.** Activities initiated by the Agency for Toxic Substances and Disease Registry (ATSDR) have included written correspondence, telephone conversations, informal meetings, and public availability sessions. ATSDR has also participated in and encouraged community involvement in DOE-sponsored public meetings. ATSDR solicited public concerns through approximately 1,700 direct mail inquiries. Approximately 500 community members responded. Information on methods of preparing fish to reduce the possibility of PCB-exposure was provided to community members during the public availability sessions.

Off-Site Contamination

➢ **ATSDR public health assessment.** On March 30, 2001, ATSDR released the public health assessment for public comment. A public meeting was held in Paducah on May 1, 2001, to present and discuss the public health assessment with the community. ATSDR concluded that the plant currently poses no apparent public health hazard for the

surrounding community, under normal operating conditions. ATSDR also concluded that historical groundwater exposure to TCE and lead was a public health hazard for children routinely drinking water from four residential wells, and that future groundwater exposures could occur if new residential wells are drilled into the northwest or northeast plume areas. Groundwater exposures to vinyl chloride and acute air exposures to uranium and hydrogen fluoride from a large past release are indeterminate public health hazards because the information available is incomplete. Past chronic exposures to operational releases were not at a level of public health concern. Other hazards were also addressed based on public concern. The final release of this document is expected in FY2002.

➢ **ATSDR Public Health Consultation Exposure Assessment of Airborne Nickel and other Metal Particulates from Historic Smelter Operations at the Paducah Gaseous Diffusion Plant** was released for public comment on Dec 31, 2001. The final award was released February 27, 2002.

Community Health Studies and Activities

➢ **ATSDR health education and promotion.** ATSDR will implement healthcare provider training in the Paducah community. Primary care providers will receive information and resources on diagnosing, treating, and counseling to assist community members who are concerned about the health impact of PGDP.

ATSDR will implement a community health education and communication strategy. Working with the Paducah community to identify the need for information and education, a comprehensive health education outreach program will be developed. This program will ensure that community members (1) know the issues of concern for PGDP, (2) understand the science and the process of the various site studies, (3) know how to protect themselves from exposure, (4) know where to get their questions answers, and (5) can share their knowledge with others. Local community infrastructure, including schools, churches, community organizations, media, or other avenues identified by the communities, will be used to provide community health education outreach.

➢ **ATSDR health study activities.** Based upon the review of data used in developing the public health assessment, drinking water exposure to TCE via residential wells has been documented at levels of concern. Fish consumption advisories are in effect due to PCB and mercury contamination. Other contaminants of concern are chromium, lead, uranium, volatile organic compounds, and TC-99. ATSDR reviewed the exposure pathways and evaluated the potential health impact to consider appropriate follow-up health activities. The population closest to the site and potentially affected by these contaminants is estimated to be less than 100. Because the incidence of any specific disease is rare in small groups, it would be difficult to attribute a specific

health outcome to PGDP-related exposures; therefore, no health studies activities are planned for this site at this time.

DOE Former Workers Medical Surveillance Program

➢ The DOE Former Worker Medical Surveillance Program at DOE Gaseous Diffusion Plants involves former production workers from the Oak Ridge K-25, Paducah, and Portsmouth gaseous diffusion plants. The project is led by Dr. Steven Markowitz of Queens College, City University of New York, and Mr. Robert Wages of the Oil, Chemical, and Atomic Workers International Union, in cooperation with the University of Massachusetts at Lowell. The Phase I needs assessment was completed in 1997.

Exposures of concern that were identified in Phase I and that will be the focus of the Phase II medical screening include asbestos, beryllium, bladder carcinogens, chlorinated solvents, fluorine compounds, nickel, noise, silica, uranium, welding fumes, and heavy metals (e.g., cadmium, lead, mercury).

The Phase II medical screening began in late 1998. Initially, approximately 200–300 former PGDP production workers were identified as potentially at high risk for lung disease. A second priority group includes approximately 2,000 workers. In 2000–2001, three significant improvements to the project were made. First, current workers were added to the screening and education program. Second, the pace of screening was accelerated. Third, screening for the early detection of lung cancer through the use of a low-dose computerized tomography scanning protocol was initiated. In September 2001 additional funding was awarded to the project by DOE to continue screening both former and current workers through at least November 2002. It is anticipated that 1,400 former and current Paducah workers will be screened during this time. The estimated number of former workers at significant risk for occupational diseases is 7,000.

Issues Needing Attention at PGDP

➢ There is concern about past worker exposure to plutonium and other transuranics.

➢ For many of the off-site samples, there is no information to identify whether the samples were collected on or near residential properties.

➢ Health outcome data for the immediate area around PGDP is unavailable. The populations of concern for the potential pathways of exposure in the area around the PGDP are extremely small, and the data available cover an area that is too large to demonstrate an impact from the site.

Proposed Activities at PGDP

Ongoing Activities

The agencies propose to continue the previously listed projects already underway and to initiate new ones. Such activities will be implemented only if feasible and deemed appropriate and beneficial to the community. The agencies will establish a coordinated plan, schedule, and lead organization for each new public health activity. The plan and schedule will be presented to all potential partners for their comment.

New Activities for FY 2002–2007

Paducah Worker Study (PAD1). In response to a congressional mandate, the University of Kentucky and the University of Louisville, under a grant from NIOSH, intend to conduct feasibility studies for a combined biometrics and epidemiological study of worker health at PGDP beginning in FY 2002.

Pantex Plant
Carson County, Texas

Background

The Pantex Plant is in Carson County, Texas, approximately 17 miles northeast of Amarillo. The area is primarily agricultural. The plant is owned by the Department of Energy (DOE) and operated under contract by Mason and Hangar-Silas Mason Company. The plant itself covers 9,100 acres. In addition, there is a buffer zone consisting of a 1,077-acre portion of Pantex Lake owned by DOE and 3,170 acres of land which DOE leases from Texas Tech University.

The plant began in 1942 as an Army Ordnance Corps facility. Nuclear operations began in 1950. The plant assembles nuclear weapons for the nation's stockpile; disassembles nuclear weapons being retired from the stockpile; evaluates, repairs, and retrofits nuclear weapons in the stockpile; demilitarizes and sanitizes components from dismantled nuclear weapons; provides interim storage for plutonium pits from dismantled nuclear weapons; develops, produces, and tests chemical explosives and explosive components for nuclear weapons; and supports DOE initiatives. (Up to 2,000 weapons must be dismantled each year until the stockpile has decreased to a predetermined number. Dismantlement is estimated to be completed by 2004.)

Past and present waste disposal practices include burning chemical wastes in unlined pits, burying construction and/or demolition debris, including asbestos, in unlined landfills, and discharging plant waste waters into surface water on-site.

Past Activities at Pantex

Off-Site Contamination

- The Agency for Toxic Substances and Disease Registry (ATSDR) public health assessment categorized the site as "no apparent public health hazard" to the off-site community. This category is used for sites where human exposure to contaminated media is occurring or has occurred in the past, but where the exposure is below levels expected to cause adverse health effects.

- **ATSDR health consultation**. In April 2000, the community near Pantex became concerned when groundwater monitoring detected trichloroethylene (TCE) contamination at 8 parts per billion (ppb). Although this concentration is above the Environmental Protection Agency's maximum concentration limit of 5 ppb, ATSDR determined that the water was safe to drink.

Community Health Studies and Activities

➢ The Bureau of Epidemiology of the Texas Department of Health (TDH) helped ATSDR evaluate citizens' public health concerns. Community members questioned excessive birth defect rates; excessive cancer rates in Armstrong, Carson, Potter, and Randall Counties; and other adverse health effects that they believed to be associated with environmental releases from the site. Specifically, TDH looked at records for bone, brain, breast, leukemia, lung, prostate, and thyroid cancer and all types of cancers combined. They found a higher than expected number of (1) females who have cancer (all types combined) in the combined Potter/Randall Counties area, (2) males who have chronic lymphocytic leukemia in the combined Potter and Randall Counties area, (3) males who died from prostrate cancer in Potter and Randall Counties, and (4) males who died from cancer (all types combined) in Potter County.

Although the number of cases or deaths reported for some types of cancers in those counties may be higher than expected compared with numbers for other populations, an ATSDR review of available environmental data indicated that it is unlikely that area residents come into contact with significant enough amounts of chemicals or radioactive substances from the plant to cause adverse health effects. Thus, exposure to off-site releases from the Pantex Plant is probably not the cause of the higher than expected incidence of cancers in this area.

➢ The number of children born in this area with certain categories of birth defects appears to be higher than expected based on similar birth defect information obtained for the entire state. To determine an underlying cause for the apparent increase, TDH evaluated parental occupation and place of employment and distribution of birth defects by zip code. No parental occupations or workplaces were notable. Few parents of children born with birth defects worked at the Pantex facility. Additionally, although one zip code near the plant (79107, which extends from the western edge of the Pantex Plant along the Potter County/Carson County border toward Amarillo) showed significant elevations for several birth defect categories, there was no consistent pattern among zip codes showing that closer proximity to the plant increased the risk for birth defects.

➢ An investigation of the incidence of low birth weight in newborns concluded that, although the incidence was increased in Armstrong County, no data indicated that proximity to the plant increased the risk for low birth weight.

➢ An evaluation of the number of people with muscular dystrophy, multiple sclerosis, amyotrophic lateral sclerosis, and lupus erythematosus in the area indicated a higher than expected number of deaths from all but lupus erythematosus. No consistent pattern of deaths from these diseases in the four-county area was found. In some instances, the number of deaths attributed to these diseases was elevated for males and not females; in other instances, the reverse was true. The causes of many of these diseases are not clearly

understood. See the Public Health Implications and Community Health Concerns Evaluation sections of the public health assessment for details about patterns of disease occurrence.

Studies of the Health of Pantex Workers

- An epidemiologic study of Pantex Plant workers was published in 1985. This study compared total and cause-specific mortality for Pantex Plant workers employed between 1951 and December 31, 1978, with expected cause-specific mortalities based on U.S. death rates. Significantly fewer deaths were observed in the workforce than would be expected based on U.S. death rates for the following causes of death: all cancers, arteriosclerotic heart disease, and digestive diseases. No specific causes of death occurred significantly more frequently than expected. Slightly elevated mortality ratios were observed for brain cancer and leukemia; however, neither excess was statistically significant. The four deaths from brain cancer occurred among those who had worked at the plant less than 5 years. The four deaths from leukemia occurred with equal frequency among those who had worked at the plant a short time and those who had worked there more than 15 years.

- **Prevention of Stress and Health Consequences of Downsizing (STDN).** The effects of downsizing on organizational climate, worker health, and performance were studied at several DOE sites, including the Pantex Plant. Data gathering included interviews, workplace observations, employee discussion groups, an employee survey distributed to more than 10,500 employees, and a historical record review. Researchers identified opportunities to reduce job stress that could lead to improved employee health and organizational well-being. Suggested intervention strategies were proposed for further research.

- **Study of Mortality among Female Nuclear Workers (MAFN).** A study of female workers from 12 DOE plants, including the Pantex Plant, was combined in a cohort mortality study, and risk estimates were developed for exposure to ionizing radiation or to chemical hazards. For the entire pooled cohort, mortality from mental disorders, diseases of the genitourinary system, and from ill-defined conditions was higher than expected. External ionizing radiation exposure in these workers appeared to be associated with increased relative risk for leukemia and, to a lesser degree, associated with increased relative risks for all cancers combined and for breast cancer.

Current Activities at Pantex

Community Involvement

The Centers for Disease Control and Prevention's National Institute for Occupational Safety and Health (NIOSH) will continue to work with labor organizations.

Off-Site Contamination

The Texas Natural Resource Conservation Commission and TDH, Bureau of Radiation Control, continue to monitor off-site areas for compliance with regulations and discharge permit limits.

Community Health Studies and Activities

- On the basis of ATSDR's determination that the number of children born in the Pantex area with certain categories of birth defects appears to be higher than what would be expected, the Texas Birth Defects Monitoring Division expanded active surveillance of birth defects to the Panhandle Region beginning with 1998 deliveries.

- **ATSDR health education and promotion.** ATSDR will provide educational material to support future health consultations. Topics could include outreach to the community to inform them about potential health effects associated with using contaminated groundwater from the perched aquifer.

NIOSH Occupational Health Studies

Pantex Cohort Mortality Study (PTXP). A NIOSH update of the cohort mortality study of the Pantex Plant expanded this cohort to include females and nonwhite males. Vital status was updated through 1995, and a standardized mortality ratio analysis was conducted. The cohort was also evaluated by statistical modeling to look for any dose-response effects. A final report is being prepared, and findings will be communicated in FY 2002. Although the plant's mission has changed, similar exposures will be encountered by current and future workers.

DOE Epidemiologic Surveillance of Current Workers

DOE's epidemiologic surveillance assesses the overall health of the current DOE work force at 14 DOE sites, including the Pantex Plant. The goal is to identify groups of workers that may be at increased risk for occupation-related injury and illness.

Issues Needing Attention at Pantex

Ongoing activities are addressing the known gaps.

Proposed Activities at Pantex

Ongoing Activities

The agencies propose to continue the previously listed projects already underway and to initiate new ones. Such activities will be implemented only if feasible and deemed appropriate and beneficial to the community. The agencies will establish a coordinated plan, schedule, and lead organization for each new public health activity. The plan and schedule will be presented to all potential partners for their comment.

New Activities for FY 2002–2007

NIOSH occupational health studies (2007), Pantex Cohort Mortality Study (PAMU). The study will involve an updating of causes of death among the previously studied Pantex cohort. An exposure assessment is also proposed to enable evaluating any suspected exposure-response relationships. It will increase the length of followup for the previously studied Pantex study population.

Portsmouth Gaseous Diffusion Plant
Piketon, Ohio

Background

The Portsmouth Gaseous Diffusion Plant is near Piketon in rural Ohio, in Pike County, approximately 55 miles south of Columbus. Since 1955, the Portsmouth Plant has been enriching uranium in the chemical form of uranium hexafluoride for use as nuclear fuel in commercial power plants. (If released to the atmosphere, uranium hexafluoride will convert to uranium oxide and hydrogen fluoride in moist air.) The United States Enrichment Corporation operates the plant for the Department of Energy (DOE).

Past Activities at Portsmouth

Off-Site Contamination

The Agency for Toxic Substances and Disease Registry's (ATSDR) public health assessment concluded that site-related contamination and hydrogen fluoride releases pose no apparent public health hazard.

Community Health Studies and Activities

➢ As part of the public health assessment process, ATSDR identified a family with neurofibromatosis type 1 (NF1), and notified the state health department. This disorder is not related to the Portsmouth Plant. NF1 is an inherited dominant genetic disease and is the most common cause of childhood cancers. It can cause café-au-lait spots, axillary freckling, neurofibromas, Lisch nodules, and learning disabilities.

➢ As part of the public health assessment, ATSDR reviewed data for causes of death for Pike, Ross, and Scioto Counties in Ohio. The incidence of cardiovascular disease was significantly higher in Pike County than other Ohio counties. Scioto County appeared to have a slightly higher mortality rate from cancer. However, after age-adjusting the data for the population, the cancer rate falls in line with the rest of the state. (Age-adjusting health outcome data is necessary to compare one county to another, because older subpopulations have higher rates of cancer and cardiovascular mortality. Age-adjusting modifies the crude mortality rate to what it would be if the population were of standard age distribution.)

ATSDR found that the age-adjusted rate for childhood cancer mortality in Pike County was roughly twice the national and state rates, but the number was too small to give a statistically reliable result. This rate was based on only five cancer deaths for the

13-year period from 1979 to 1991. None of the childhood cancers were of the same type and therefore could not be related to a common cause.

Because the community expressed concerns about releases of uranium hexafluoride, ATSDR reviewed health outcome data related to renal diseases. No increase in the renal failure rate was identified in surrounding communities.

Studies of the Health of Portsmouth Workers

- The Centers for Disease Control and Prevention's National Institute for Occupational Safety and Health (NIOSH) conducted a cohort study of the Portsmouth workforce to determine whether mortality was associated with occupational exposures at the Portsmouth Gaseous Diffusion Plant (PORT). The study report issued in 1987 revealed statistically non-significant elevated standardized mortality ratios for stomach cancer and for cancers of the lymphatic and hematopoietic system. Deaths from all cancers in this study population was below what was expected based on the U.S. population.

- **Mortality Patterns among Uranium Enrichment Workers at the Portsmouth Gaseous Diffusion Plant (PK1P).** NIOSH investigators conducted a follow-up mortality study and a nested case-control study of Portsmouth workers. The study examined the causes of death among all site workers employed by the facility between September 1, 1954, and December 31, 1991. Possible relationships were evaluated for deaths from several types of cancers and exposures to ionizing radiation and certain chemicals (fluoride, uranium metal, and nickel). Because of undocumented neutron exposure and many confounders present at the facility, NIOSH performed case-control analyses for hematopoietic, lung, and stomach cancers to investigate possible dose-response relationships.

- Overall cohort mortality was significantly less than expected (88% alive as of December 31, 1991), when compared to the U.S. population, as was mortality from all cancers. No statistically significant excesses in mortality from any specific cause were identified. Analyses of possible relationships between causes of death and the identified exposures failed to reveal any clear dose-response trends. For leukemia, no effect of cumulative exposure to either external or internal radiation was identified. Additionally, no dose-response relationships were observed for cancers of the stomach, lung, Hodgkin disease, lymphoreticulosarcoma, and all other cancers combined. Worker deaths from cancers of the lympho-hematopoietic tissue, including leukemia, equaled U.S. rates. Stomach cancer deaths were greater than expected but this difference was not statistically significant. Deaths from these cancers had been found to be slightly elevated in a previous NIOSH study of this plant.

Current Activities at Portsmouth

Community Involvement

No current HHS community involvement activities at Portsmouth exist.

Off-Site Contamination

No current studies of off-site contamination at Portsmouth exist.

Community Health Studies and Activities

No community health activities or studies are currently being conducted at Portsmouth.

NIOSH Occupational Health Studies

No current NIOSH occupational health studies are occurring at Portsmouth.

DOE Former Workers Medical Surveillance Program

- The DOE Former Worker Medical Surveillance Program at Department of Energy Gaseous Diffusion Plants involves former production workers from Oak Ridge K-25, Paducah, and Portsmouth. The project is led by Dr. Steven Markowitz of Queens College, City University of New York, and Mr. Robert Wages of the Oil, Chemical, and Atomic Workers International Union, in cooperation with the University of Massachusetts at Lowell. The Phase I needs assessment was completed in 1997, and the Phase II medical screening began in late 1998 and is scheduled to run through 2002. Initially, approximately 1,260 former production workers were identified as potentially at high risk. Exposures of concern that were identified in Phase I and that will be focused on during the Phase II medical screening include asbestos, beryllium, bladder carcinogens, chlorinated solvents, fluorine compounds, nickel, noise, silica, uranium, welding fumes, and heavy metals (e.g., cadmium, lead, mercury).

- DOE plans to expand the Former Worker Medical Surveillance Program to current workers and additional former workers at the three gaseous diffusion plants.

Issues Needing Attention at Portsmouth

Gaps in knowledge of the morbidity patterns of Portsmouth workers need to be addressed.

Proposed Activities at Portsmouth

Ongoing Activities

The agencies propose to continue the previously listed projects already underway.

New Activities for FY 2002–2007

No new activities are proposed at this time.

Rocky Flats Plant
Golden, Colorado

Background

The Rocky Flats Plant is located in northern Jefferson County, Colorado, approximately 16 miles northwest of Denver. The facility originally covered 2,000 acres, but a 4,550-acre buffer zone was added in 1974. The main processing operations are confined to approximately 384 acres in the buffer zone. The plant ceased operation in 1992.

The plant produced and assembled components for nuclear weapons. These operations used aluminum, beryllium, plutonium, stainless steel, and uranium. The facility also recovered plutonium and separated and performed research on americium.

Releases of pesticides, plutonium, solvents, and tritium have contaminated groundwater, soils, and surface water sediments at various locations on the facility. Since 1992, site personnel have been involved exclusively with cleanup, waste management, decontamination and decommissioning activities.

Public health issues at Rocky Flats include plutonium exposures to workers cleaning up the site, exposures to the public from plutonium-contaminated soils being transported off-site during remediation, and inadequate record-keeping of those workers on the site at any given time (which may impact future exposure assessments).

Because of several fires and operational releases, plutonium has migrated off-site and contaminated soil and sediment around the facility. Soil and groundwater have also been contaminated by leaking waste drums that contain trichloroethene (also known as trichloroethylene) and plutonium shavings. Public health concerns related to these releases have led the Colorado Department of Public Health and Environment to oversee the development of exposure assessments and dose reconstruction activities.

Past Activities at Rocky Flats

Off-Site Contamination

- Plutonium contamination of soils and sediments has been documented beyond the boundaries of the federally owned land. Additionally, three evaporation ponds have contributed to nitrate contamination of groundwater.

- An Agency for Toxic Substances and Disease Registry (ATSDR) health consultation concluded that heavy metals and radioisotopes in environmental media associated with

Operable Unit 3 (off-site and east of the fence line) are present at levels below health hazard and that Operable Unit 3 could be safely released for public use.

Community Health Studies and Activities

➢ In October 1993, the Health Advisory Panel overseeing the Rocky Flats Historical Public Exposures Studies drew these preliminary conclusions about Phase I:

- Community exposures from past Rocky Flats contaminant releases appear to be relatively small,
- A 10-mile area east and southeast of the site received the highest radiation doses,
- The key Rocky Flats contaminant releases were plutonium (released from a fire in the plant in 1957 and from the 903 Pad from 1964 through 1969) and carbon tetrachloride (a solvent used to clean plutonium parts), which was emitted during routine industrial operations, and
- The highest plutonium exposures occurred before 1975.

➢ Carl Johnson examined cancer incidence from 1969–1971 among non-Hispanic whites in the Denver area to determine if exposure to a small concentration of plutonium and other radionuclides had increased the incidence of cancer. The author concluded that during the period studied, cancer incidence increased with increasing plutonium soil concentrations and that exposure of the public to low concentrations of plutonium and other radionuclides may affect the incidence of total cancer and cancers known to be associated with radiation exposure.

➢ Crump et al. re-examined the 1969–1971 Johnson data, and also analyzed data from 1979–1981. The findings paralleled the earlier Johnson results for 1969–1971. For 1979–1981, significant positive trends were observed in males for total cancer, "radiosensitive cancer" (as defined by Biological Effects of Ionizing Radiation III), and respiratory cancer; and in females for total cancer, radiosensitive cancer, and gastro-intestinal tract cancer.

The authors examined the possible effects of urbanization on cancer incidence by grouping census tracts by distance from the Colorado State capitol building. Cancer incidence rates were found to decrease in all directions from the capitol, including the direction of Rocky Flats. After controlling for distance from the capitol, the statistically significant association of increases in various cancers among those living near Rocky Flats disappeared. When Area I, the area closest to the plant, was compared to the whole Denver metropolitan area, no excess was found in either study period for either males or females for total cancer, radiosensitive cancer, or respiratory cancer. The study did not support a correlation between cancer incidence and environmental exposure to plutonium from the plant.

➢ The Colorado Central Cancer Registry (1998) compared the incidence of cancer for areas near the plant with cancer incidence in the remainder of metropolitan Denver. The report found that the incidence of all cancers combined was not higher than expected for each of the 10 study areas nor for all study areas combined. The study also reported that the incidence of male lung cancer was higher than expected in two of the study areas, but that of the groups showing increases, at least 75% were smokers. The state continues to monitor cancer incidence and will perform additional analyses as needed.

➢ The Rocky Flats Historical Public Exposures Studies was completed in September 1999. Of the 8,000 chemical and radioactive materials used at the plant, plutonium and carbon tetrachloride releases were the major contributors to off-site exposures. Releases were highest in the late 1960s, and inhalation was the most important route of exposure. The key findings of the studies are summarized as follows:

- The largest releases of plutonium from the plant came from a 1957 fire at the plant and from a waste oil storage area in the late 1960s. Between 10 and 50 curies (or between 130 and 670 grams) of plutonium were released into the air, traveling off-site, predominantly east of the plant, as confirmed by measurements of plutonium concentrations in soil.

- People who lived near the plant and led active, outdoor lifestyles (such as ranchers or laborers) had the highest level of exposure to airborne plutonium. The increased risk of developing cancer for people with this lifestyle ranges between 1 in 100 million and 1 in 10,000, with a median value of 2.5 chances in 1 million. Researchers are confident that the true value for this risk has a 90% chance of being within this range. This risk is about the same as a person's increased risk from being exposed to the plutonium in fallout from U.S. weapons testing.

- Between 1,100 and 5,400 tons of carbon tetrachloride, a solvent used at the plant for cleaning and degreasing, was the major chemical of concern released from the plant. The increased cancer risk for a rancher or laborer was estimated to be between 6 in 10 million and 1 in 100,000, with a median value of 2.5 in 1 million.

- An individual's location, lifestyle, and period of exposure were found to have a greater effect on health risks than gender or age. For example, people who moved to areas near Rocky Flats after 1970 were exposed to much smaller concentrations of plutonium, and people who spent more time indoors had smaller risks than a person who worked outdoors all day.

- Other materials examined included beryllium, dioxin, uranium, and tritium. Health risks due to releases of these materials from the plant were considerably less than risks from plutonium or carbon tetrachloride.

- The study concluded that cancer risks from all materials studied are low compared to cancer risks from other causes, and follow-up epidemiologic studies were not recommended. It was recommended that federal, state and citizen organizations actively monitor current and future operations at the site to prevent unnecessary off-site exposures from occurring in the future. More information on the studies is available through the Colorado Department of Health and Environment Web site at *www.cdphe.state.co.us/rf*.

Studies of the Health of Rocky Flats Workers

➢ Epidemiology studies of workers at the plant showed excess mortality from benign and unspecified brain tumors. The relationship between the brain tumors and various radiation exposures has been further investigated but remains unclear. Additionally, workers with higher amounts of plutonium intake were more likely than those with smaller amounts to have died from lymphatic and hematopoietic cancers as well as from all combined causes of death. These latter findings were not related to any measure of on-site radiation exposure. The Rocky Flats study was updated with deaths through 1995 and with cancer incidence data. The study was completed in 2000.

➢ **Study of Mortality among Female Nuclear Workers (MAFN).** A study of female workers from 12 DOE plants, including Rocky Flats, was combined in a cohort mortality study, and risk estimates were developed for exposure to ionizing radiation or to chemical hazards. For the entire pooled cohort, mortality from mental disorders, diseases of the genitourinary system, and from ill-defined conditions was higher than expected. External ionizing radiation exposure in these workers appeared to be associated with increased relative risk for leukemia and, to a lesser degree, associated with increased relative risks for all cancers combined and for breast cancer.

➢ **Exposure Assessment of Hazardous Waste, Decontamination and Decommissioning, Cleanup Workers (HAWW) feasibility.** Feasibility studies at seven DOE sites, including Rocky Flats, determined that the availability of records to identify workers and their primary activities, exposures, work histories, and medical information varied significantly from site to site. The necessary information to conduct exposure assessment, hazard surveillance, or epidemiology studies of remediation workers is currently not readily available. Within sites, data systems are fragmented and data management is inconsistent in the current environment of decentralized management and increased subcontracting.

Current Activities at Rocky Flats

Community Involvement

The Colorado Department of Public Health and the Environment has established the Rocky Flats Health Advisory Panel to guide and oversee the dose reconstruction project. The panel

sponsored extensive public outreach and involvement activities, some of which were increased in 1999 to interpret and promulgate study findings. Quarterly newsletters have described study progress and advertised panel meetings and other public meetings. Fact sheets and papers on technical topics have been produced to disseminate information and ask for input from stakeholders, and public meetings have been held. Panel members have spoken to many civic groups and are available for questioning.

Off-Site Contamination

➢ Patterned after the historical public exposure study and its oversight panel, another citizen panel is overseeing an independent review of the safe levels of radioactivity remaining in the soil after remediation. The panel is reviewing calculations used to determine how much radioactive material remaining in the soil will produce the allowable dose of 15 millirems (mrem) per year to an office worker on site or 85 mrem per year to a hypothetical future resident living on the site. Citizens were concerned about the levels set for Rocky Flats because the rates appeared higher than for some other sites and the citizens believed the rates were set without sufficient public involvement.

➢ **NCEH Rocky Flats historic public exposure studies.** The Centers for Disease Control and Prevention's National Center for Environmental Health (NCEH) will work with the Colorado State Department of Public Health and Environment to complete important follow-up tasks from the dose reconstruction project. These tasks include considering developing interactive software to determine individual risk, applying environmental monitoring data for validation of movement of plutonium in the environment, and completing the analysis of plutonium risk factors.

NIOSH Occupational Health Studies

➢ **Epidemiological evaluation of cancer and occupational exposure at Rocky Flats (RKFL).** Under a NIOSH cooperative agreement, the Colorado Department of Public Health and Environment and the University of Colorado are completing a cancer incidence study, an update of the mortality study, and a nested case-control study of lung cancer. These studies will determine if workers at the plant have elevated rates of cancer incidence or an increased risk of death from any disease as compared to the U.S. population. Worker exposures to neutron and internal radiation are being evaluated, and historical worker exposures to carcinogens are being reconstructed. Collection and analysis of the data are complete, and the final report is being written.

➢ **Lung Fibrosis in Plutonium Workers (LFPW).** Plutonium-induced lung fibrosis has been observed in animals, but nonmalignant respiratory disease has not been studied in an exposed-worker population. The National Jewish Center for Immunology and Respiratory Medicine, sponsored by a NIOSH grant, is conducting a study to determine whether workers in facilities involving plutonium are at increased risk for developing

fibrosis. Lung biopsies of plant workers will be examined to investigate any association between lung fibrosis and exposures to plutonium-239 and other occupational exposures. The communication and release of the final report will occur in FY 2002.

➢ **Sentinel Exposure Event Surveillance/evaluation at DOE sites (SEES).** The University of Colorado, under a NIOSH-funded grant, is supporting a project to create a system for Sentinel Exposure Event (SEE) Surveillance and Evaluation at DOE sites. Based on a job/task evaluation and analysis, the SEE system incorporates exposure level measurements, worker-specific task definitions, and observational data such as controls and conditions or exposure into a special data recording and reporting system. This system is designed to produce reports for worker information programs and for the evaluation of occupational exposures in identifying and prioritizing intervention efforts. The SEE system has been developed and implemented as a pilot at the plant, and it will be evaluated for its applicability at other DOE sites. Data collection and analysis has been completed, and the final report is expected in FY 2002.

DOE Epidemiologic Surveillance of Current Workers

DOE's epidemiologic surveillance assesses the overall health of the *current* DOE work force at 14 DOE sites, including the Rocky Flats Plant. The goal is to identify groups of workers that may be at increased risk for occupation-related injury and illness.

DOE Former Workers Medical Surveillance Program

➢ The DOE Medical Monitoring Program for Former Workers at Rocky Flats Plant reviews information to determine whether former plant workers might eventually have health problems due to their employment at the site. The University of Colorado Health Sciences Center carries out this project. Phase I included collecting and evaluating existing chemical exposure data from the site.

➢ Since 1991, DOE has been supporting a Beryllium Surveillance Program that provides medical monitoring program for workers who were exposed to beryllium during their employment at the plant. Workers who think they have been exposed to beryllium and who volunteer to participate in the program receive medical examinations. Those who have lung problems are referred to a pulmonary clinic for a confirmed diagnosis. A total of 8,103 former plant workers were screened, between June 1991 and December 1999, with 68 diagnosed with chronic beryllium disease.

Issues Needing Attention at Rocky Flats

➢ The risks to the public from environmental plutonium exposures need to be determined. An example of potential exposure is the plutonium deposited in the silt of both Standley Lake and Great Western Reservoir within Operable Unit 3.

➢ Morbidity studies and non-cancer studies need to be conducted.

Proposed Activities at Rocky Flats

Ongoing Activities

The agencies propose to continue the previously listed projects already underway and to initiate new ones. Such activities will be implemented only if feasible and deemed appropriate and beneficial to the community. The agencies will establish a coordinated plan, schedule, and lead organization for each new public health activity. The plan and schedule will be presented to all potential partners for their comment.

New Activities FY 2002–2007

➢ **ATSDR public health assessment.** ATSDR plans to initiate the public health assessment when resources become available.

➢ **ATSDR health education and promotion.** ATSDR will continue to support and coordinate the health education activities of the Colorado State Department of Health and the Environment.

Salmon Test Site
Lamar County, Mississippi

Background

The 1,470-acre Salmon Test Site (formerly called the Tatum Dome Test Site) is located in Lamar County, 21 miles southwest of Hattiesburg, Mississippi. The salt dome is about 5,000 feet in diameter and 1,500 feet below ground. The Atomic Energy Commission selected the site for seismic experiments. The site was deactivated in 1972.

In 1964 and 1966, two nuclear detonations were exploded in the salt dome. The 1964 detonation created a cavity in the salt dome that was used for a second detonation two years later. The first event, a 5.3-kiloton (± 0.5) yield nuclear detonation, imploded 2,710 feet below ground. The second event was a 380-ton yield nuclear detonation. These detonations were contained within the salt dome; all environmental monitoring data for tritium (the source of radiation exposure) immediately after the detonations and subsequently have shown no increase above background levels.

Surrounding area residents recently raised concerns about health effects, primarily cancer, related to the site. The Department of Energy (DOE) initiated a study to determine if there was a relationship between cancer deaths in Lamar County and residence near the Salmon Test Site.

Past Activities at the Salmon Test Site

Site and Off-Site Contamination

- Environmental monitoring activities have been conducted at the site since the first test took place in 1964. Reports by the Mississippi State Department of Health (MSDH), Division of Radiological Health (DRH) and the Environmental Protection Agency (EPA) indicated that there were no gas or particulate releases during any of the nuclear detonations. The U.S. Geological Survey and a private contractor conducted the testing. Results of these analytic tests showed no increase in the normal background radiation. The results of the monitoring program are documented in a report prepared by the DOE Field Office, Nevada (DOE, 1978) and in the 1990 annual reports prepared by EPA and DRH.

- When the Salmon Site was deactivated in 1972, a long-term hydrologic monitoring program was initiated by DOE and EPA and was conducted by EPA's Environmental Monitoring Systems Laboratory (EMSL) in Las Vegas. In 1977, DRH participated in this cooperative monitoring program, which was designed to regularly evaluate the test

site and surrounding areas to ensure that residue left from the tests did not affect drinking water.

Since 1972, the long-term hydrologic monitoring program and the State of Mississippi have monitored all accessible wells, boreholes, creeks, and ponds on the site. EPA sampled groundwater from 20 residential wells and from 54 wells on- and off-site. Data from these analyses were compared to baseline data of samples taken when the test site was initially closed.

The results of this monitoring program are summarized as follows:

- Groundwater monitoring indicated that the salt dome was intact and that no tritium was leaking outside the dome.

- The tritium concentrations found in deep wells, both on- and off-site, were similar to worldwide background levels.

- Low levels of tritium have been measured in water from shallow boreholes in the area where the tests were conducted. The water in these boreholes was brackish and undrinkable. The tritium found there was from residue brought to the surface by drilling activities conducted immediately after the tests. No health hazard was identified because (1) the water was not used for drinking, (2) the tritium concentrations were low, and (3) the test site was off limits to the public.

- The highest tritium concentration was 48 picocuries per liter (pCi/L); the EPA drinking water standard for tritium is 20,000 pCi/L.

Community Health Studies and Activities

DOE conducted a mortality study to determine if there were excess cancer deaths among former residents in the area near the Salmon Test Site. The Public Health Statistics Division of MSDH provided computerized data for all deaths among the approximately 27,000 Lamar County residents between January 1, 1980, and December 30, 1991.

The study identified 562 (25.7%) deaths due to cancer and 1,623 (74.3%) deaths due to other causes. There were too few cancer deaths among children to permit analysis. No apparent relationship between cancer death and residence near the Salmon Test Site was found. The risk of cancer was no higher for those living near the site than for those living farthest away, nor for those living in one direction compared to another, although there was a non-statistically significant increase in those living north of the site.

The findings of this study are consistent with a previous investigation by the Mississippi State Department of Health, which analyzed vital data records. The study found that the

age-adjusted mortality rates for all cancers combined and for 34 site-specific cancers for Lamar County were similar to those for Mississippi and other counties within the state for 1980–1988.

Studies of the Health of Salmon Test Site Workers

No epidemiologic studies of former workers at the Salmon Test Site exist.

Current Activities at the Salmon Test Site

- No current studies are being conducted in populations near the site. The Mississippi Department of Health continues to monitor private wells quarterly, and DOE continues to do monitoring annually.

- A DOE report on remediation activities has been completed and is being reviewed by the State. DOE completed a mathematical model of groundwater monitoring of the aquifer plume. The model did not suggest any off-site exposure.

- DOE completed a risk assessment around the site.

- DOE has agreed to fund the installation of a water system in the area. It will be more cost-effective than continuing the water testing over the next 50 years.

Issues Needing Attention at the Salmon Test Site

No additional issues have emerged.

Proposed Activities at the Salmon Test Site

No additional activities are proposed.

Savannah River Site (SRS)

Aiken, South Carolina

Background

The Savannah River Site (SRS), located in South Carolina, was built in the early 1950s to produce materials for the manufacture of nuclear weapons, primarily tritium and plutonium-239. The operations at the site were adjusted to meet the country's changing defense needs. A major operational change has been the permanent closure of the five reactors used to produce plutonium and tritium and a shift in the late 1980s to recycle this material to maintain the nation's supply of nuclear weapons. This recycling activity allows the United States to stretch its supply of tritium and reduces the need to produce more of the material. In addition, other production, storage, and recycling operations at the site are currently under review through an Environmental Impact Statement Process. SRS is a Department of Energy (DOE) facility currently being operated by Westinghouse Savannah River Company.

Although tritium has been a long-time concern at the site, potential adverse health effects due to exposure to atmospheric and surface water releases of chemicals and other radionuclides from the site are also of concern. Routine and inadvertent releases occurred from the five reactors (100 area), separations facilities (200 area), and other operational facilities. Community residents are also concerned about groundwater and environmental justice issues and about the health of workers at the site.

Past Activities at SRS

Off-Site Contamination

- In January 1995, the South Carolina Department of Health and Environmental Control (DHEC), the Georgia Department of Natural Resources, and the Environmental Protection Agency jointly issued a fish consumption advisory to provide guidelines for eating fish taken from selected portions of the Savannah River and Steel Creek, Lower Three Runs Creek, and Fourmile Branch. This advisory was based on mercury levels in fish samples taken from the Savannah River. As a result of additional sampling of fish in tributaries to the Savannah River, the DHEC expanded the advisory in May 1996 to include fish in those creeks based on measured levels of cesium-137 and strontium-90.

- The Centers for Disease Control and Prevention's National Center for Environmental Health (NCEH) is performing a dose reconstruction study to assess the dose and risk to the surrounding community from past exposure to contaminants released from the site. NCEH has completed two phases of the Savannah River Site Environmental Dose Reconstruction Project: document retrieval and assessment and the reconstruction of

historical releases of radioactive materials and chemicals from SRS between 1954 and 1990. In Phase I, all records stored at SRS and other locations were searched and interviews with current workers and retirees were conducted. Several thousand documents were found that could be used to estimate chemical and/or radionuclide releases to the air and water around SRS.

The *Savannah River Site Environmental Dose Reconstruction Project; Phase II: Source Term Calculation and Ingestion Pathway Data Retrieval Evaluation for Materials Released from the Savannah River Site* has been completed by NCEH and is available on CD-Rom and on paper. During this phase, it was estimated that the key radionuclides released to air were iodine-131, iodine-129, tritium, argon-41, plutonium-239, and plutonium-240. Key releases to water were cesium-137, tritium, strontium-90, cobalt-60, phosphorus-32, and iodine-131. Also identified were 22 key chemicals and heavy metals released to the water and air from the site. None of the chemicals and radioactive materials released from the site have migrated off-site via groundwater.

Studies of the Health of SRS Workers

- In a recent multi-site study, sponsored by a Centers for Disease Control and Prevention's National Institute for Occupational Safety and Health (NIOSH) grant, the University of North Carolina found an effect based on age. External doses received at older ages were associated with an increased risk of multiple myeloma, but doses at younger ages were not.

- The mortality of 9,860 white male SRS workers was evaluated. They reportedly had a higher rate of leukemia than the U.S. population through 1980. This was concentrated among hourly workers employed before 1955 who worked at SRS from 5 to 15 years. The leukemia death rate through 1986 was higher than expected only for those deaths occurring from 1965 through 1969. Preliminary findings from a recent study of SRS workers reported that the leukemia mortality rate was not higher than the U.S. rate through 1995.

- **Exposure Assessment of Hazardous Waste, Decontamination and Decommissioning, Cleanup Workers (HAWW).** Feasibility studies at seven DOE sites, including SRS, determined that the availability of records to identify workers and their primary activities, exposures, work histories, and medical information varied significantly from site to site. The necessary information to conduct exposure assessment, hazard surveillance, or epidemiology studies of remediation workers is currently not readily available. Within sites, data systems are fragmented and data management is inconsistent in the current environment of decentralized management and increased subcontracting.

- **Study of Mortality among Female Nuclear Workers (MAFN).** A study of female workers from 12 DOE plants, including SRS, was combined in a cohort mortality study,

and risk estimates were developed for exposure to ionizing radiation or to chemical hazards. For the entire pooled cohort, mortality from mental disorders, diseases of the genitourinary system, and from ill-defined conditions was higher than expected. External ionizing radiation exposure in these workers appeared to be associated with increased relative risk for leukemia and, to a lesser degree, with increased relative risks for all cancers combined and for breast cancer.

➢ An Agency for Toxic Substances and Disease Registry (ATSDR) health consultation for the D-Area seepage basin determined that the dioxin levels did not pose a health hazard to workers if recommended worker precautions were taken during removal actions.

Current Activities at SRS

Community Involvement

➢ **Savannah River Site Health Effects Subcommittee.** NCEH and ATSDR will continue to work with the SRS Health Effects Subcommittee. The subcommittee is a vehicle for the public and tribal nations, including the Catawba Tribe of South Carolina, to express concerns and provide advice and recommendations on the agencies' public health activities and research at SRS.

Off-Site Contamination

➢ **NCEH SRS dose reconstruction.** NCEH will complete a risk-based screening analysis in Phase III of the Savannah River Site Environmental Dose Reconstruction to determine which contaminants and exposure pathways have the highest potential for harming people. To accomplish this, NCEH is currently examining the literature to identify biologically plausible health outcomes that could be related to the radionuclides and chemical contaminants identified in Phase II.

In Phase IV, NCEH will develop site-specific models and parameter values for those contaminants and exposure pathways selected in Phase III. These models will be used in Phase V to calculate environmental exposures and doses. These estimates will include a quantitative uncertainty analysis.

The dose models developed in Phase V will be used to develop probabilistic estimates of risk (for realistic scenarios and for the population). NCEH is currently evaluating the information available to conduct these analyses, including population data, literature relating to select health outcomes/exposures, existing health outcome data for the region, and risk models. NCEH will collect information needed to estimate the size and dynamics of the off-site population and background rates of disease, develop risk estimation models, and estimate the lifetime risk of select cancers and other health

effects (when possible). It is highly likely that for non-neoplastic health effects only a qualitative assessment of risk will be possible. NCEH will develop and implement a plan to effectively communicate the results of the dose assessment and risk analysis to stakeholders.

➢ **ATSDR public health assessment.** As resources are available, ATSDR will initiate work on the public health assessment for SRS to (1) evaluate the potential for environmental exposures to the public (past, present, and future), (2) assess the impact on public health (past, present, and future), and (3) prevent and mitigate further public exposure. To avoid duplicating efforts, ATSDR will use the data and information collected by NCEH during their dose reconstruction activity.

Community Health Studies and Activities

➢ **ATSDR health education and promotion.** ATSDR will implement healthcare provider training for communities near SRS. Primary care providers will receive information and resources to diagnose, treat, and counsel persons concerned about the health impact of the site.

➢ **ATSDR health communication strategy.** ATSDR, in collaboration with NCEH, will implement a community health education and communication strategy. The agencies will work with the Savannah River Site Health Effects Subcommittee, Savannah River Site Citizens Advisory Board, and the communities around the site to identify the community needs for information and education. Based on this information, a comprehensive health education outreach program will be developed.

➢ **ATSDR community needs assessment for health education and promotion.** ATSDR, NCEH, and NIOSH are working with local health and community representatives in Chatham County to review the information collected during the 1996 community needs assessment process and to assist with any necessary followup.

NIOSH Occupational Health Studies

➢ **Multi-site Case-control Study of Lung Cancer and External Ionizing Radiation (LUNG).** This ongoing NIOSH case-control study combines worker information from multiple sites, including SRS, to clarify the relationship between lung cancer and external radiation exposure.

➢ **Multi-site Leukemia Case-control Study (LCCS).** This ongoing NIOSH case-control study combines worker information from multiple sites, including SRS, to explore the relationship between external radiation and leukemia risk among 250 workers with leukemia compared to similar workers who do not have leukemia.

➢ **Cohort Mortality Study of DOE Chemical Laboratory Workers (CLWS).** NIOSH is studying the mortality experience of chemical laboratory workers from multiple sites, including SRS. Limited previous studies outside the DOE complex suggest an increased risk of cancer in these workers.

DOE Epidemiologic Surveillance of Current Workers

DOE's epidemiologic surveillance assesses the overall health of the *current* DOE work force at 14 DOE sites, including SRS. The goal is to identify groups of workers that may be at increased risk for occupation-related injury and illness.

DOE Former Workers Surveillance Program

➢ Researchers at the Environmental and Occupational Health Sciences Institute at Rutgers University are updating the SRS worker cohort. Preliminary analyses indicate that the elevated rates of leukemia mortality noted previously are limited to the 1960s. Rates have dropped since then and are now slightly below U.S. rates.

➢ The DOE Savannah River Site Former Production Workers Medical Surveillance Program is conducted through the Medical University of South Carolina. The target population is former production workers at SRS (approximately 25,580) who worked from inception to the present. The hazardous exposures that justify medical surveillance include asbestos, beryllium, dioxane, hydrazine, hydrogen sulfide, external ionizing radiation, internal radiation, noise, perchloroethylene, polychlorinated biphenyls, transuranic elements, and trichloroethylene.

➢ The DOE Savannah River Building Trades Medical Screening Program is conducted through the Center to Protect Workers' Rights. The target population is former and current building trades workers at SRS who worked from inception to the present. The hazardous exposures that justify medical surveillance include asbestos, cadmium, chromium, heavy metals, ionizing radiation, lead, mercury, silica, solvents, noise, and welding fumes. Beryllium and tritium are also being considered for medical surveillance, but more tentatively.

Issues Needing Attention at SRS

➢ Depending on the results of the environmental dose reconstruction, a determination may need to be made of the potential health risks that might result from past exposures to chemicals and radionuclides released from SRS to surrounding communities.

Applicable to SRS and other Sites

- Further epidemiologic research is needed to evaluate the protection against potentially adverse health outcomes in the workplace provided by current occupational radiation exposure limits. Many of these exposure limits were developed from bomb survivor and radiation therapy exposure data that differs in intensity, duration, route of exposure, and frequency from that found in the workplace.

- Internal dosimetry of radiation workers requires numerous assumptions and the relationship between internal radiation dose and health effects needs to be evaluated.

- Results from ongoing mortality studies need to be evaluated to improve understanding of causes of cancer and chronic diseases. Additional studies can be proposed to focus on a single disease in worker groups.

- Complete records, including industrial hygiene and work history data for the various levels of subcontractors at each site, must be made available.

Proposed Activities at SRS

Ongoing Activities

The agencies propose to continue the previously listed projects already underway and to initiate new ones. Such activities will be implemented only if feasible and deemed appropriate and beneficial to the community. The agencies will establish a coordinated plan, schedule, and lead organization for each new public health activity. The plan and schedule will be presented to all potential partners for their comment.

New Activities for FY 2002–2007

- **ATSDR health care provider training and community health education.** ATSDR is partnering with community leaders and other agencies to conduct a community health education needs assessment, which will be used to develop health education programs for the community and healthcare professionals. The agencies will also continue to work with the Savannah River Site Health Effects Subcommittee, Savannah River Site Citizens Advisory Board, and the communities around the site to identify needs for information and education. Based on this information, a comprehensive health education outreach program will be developed.

- **ATSDR environmental justice activities.** In accordance with Executive Order No. 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, ATSDR will make environmental justice part of its mission by

identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects on minority and low-income populations.

➢ **NIOSH occupational health studies (2007), Savannah River Site Cohort Update (SRSU).** Because of prior investigations conducted by NIOSH and other investigators at the Savannah River Site, the quality of records has been improved and a more informative analysis of occupational exposures will be possible. Workers at this site have documented exposures to plutonium, tritium, and external radiation.

Shipyards in the Naval Nuclear Propulsion Program
Various Locations

Background

The first nuclear-powered ship, the USS *Nautilus*, which went to sea in 1955, was built in Groton, Connecticut. Since then, the shipyards in the Naval Nuclear Propulsion Program have developed shipyard nuclear capabilities at Kittery, Maine (near Portsmouth, New Hampshire); New London, Connecticut; Norfolk and Newport News, Virginia; Charleston, South Carolina; Mare Island, California; Puget Sound, Washington; and Pearl Harbor, Hawaii. At each of these sites, nuclear-powered ships have been constructed, overhauled, repaired, refueled, or deactivated.

Past Activities at Shipyards in the Naval Nuclear Propulsion Program

Studies of the Health of Nuclear Naval Shipyard Workers

➢ A cohort mortality epidemiologic analysis of workers at the Portsmouth Naval Shipyard (PNS) completed by the Centers for Disease Control and Prevention's and National Institute for Occupational Safety and Health (NIOSH) found no significant excess mortality from any cause. Later case-control studies of lung cancer and leukemia in this group of workers did have positive findings. However, these findings were not, in all likelihood, linked to occupational radiation exposure.

Excess lung cancer mortality was associated with workers with cumulative occupational doses of 1.0 to 4.999 rem. These same workers were also potentially exposed to welding fumes and asbestos. The relative importance of welding fumes and asbestos in the development of the lung cancers could not be determined.

In the other case-control study, significant excesses of leukemia were found for welders and electricians, but no relationship was found between leukemia and radiation exposure.

➢ In 1991, researchers from The Johns Hopkins University completed an epidemiological study of the health of workers at the six Navy shipyards and two private shipyards that serviced Navy nuclear-powered ships. This study evaluated 70,730 civilian workers from 1957 through 1981, to determine whether there was an excess risk of leukemia or other cancers associated with exposure to low levels of gamma radiation.

The study found no evidence that the health of people involved in work on U.S. nuclear-powered ships has been adversely affected by exposure to low levels of radiation

incidental to this work. In fact, the overall death rate among radiation-exposed shipyard workers was less than the death rate for the U.S. population.

The death rate for cancer and leukemia among the radiation-exposed workers was slightly lower than that for non-radiation-exposed workers and that for the general U.S. population. An increased rate of mesothelioma, a rare cancer linked to asbestos exposure, was found in both radiation-exposed and non-radiation-exposed shipyard workers, although the number of cases was small.

Current Activities at Shipyards in the Naval Nuclear Propulsion Program

Off-Site Contamination

No ongoing studies of off-site contamination exist.

Community Health Studies and Activities

No ongoing community health studies exist.

NIOSH Occupational Health Studies

- **Mortality Update study of Portsmouth Naval Shipyard Workers (PNSP).** The NIOSH cohort mortality study of Portsmouth Naval Shipyard (PNS), a mortality study of civilian employees at PNS, will be updated through 1997. Through an agreement with the Naval Sea Systems Command, the cohort has been expanded to include all individuals employed through 1992. Case-control studies will also be done, as indicated by a review of the data. The study will also determine whether external ionizing radiation is related to the risk of death from leukemia or lung cancer and whether asbestos exposure or other known carcinogens present at the shipyard are confounding these relationships.

- **International Collaborative Study of Nuclear Industry Workers (IARC).** NIOSH has withdrawn the submission of its PNS study data from the international collaborative study of nuclear workers in 17 countries due to study protocol changes introduced by the International Agency for Research on Cancer in FY 2001. This study is the largest cancer mortality study ever of nuclear workers.

- **Multi-site Leukemia Case-control Study (LCSS).** This ongoing NIOSH case-control study combines worker information from multiple sites, including PNS, to explore the relationship between external radiation and leukemia risk among 250 workers with leukemia compared to similar workers who do not have leukemia.

Issues Needing Attention at Shipyards in the Naval Nuclear Propulsion Program

The Matanoski cohort mortality study of civilian naval shipyard employees, including those at PNS, was funded by DOE. The study followed approximately 70,000 nuclear Navy workers for 13 years, through 1981. An update of this study at this time would add at least 15 years of mortality data for this cohort. This is an important cohort to follow up due to its size, the exceptional quality of the exposure information available, and because the radiation exposure to this cohort is without the confounding factor of internal dose.

Proposed Activities at Shipyards in the Naval Nuclear Propulsion Program

Ongoing Activities

The agencies propose to continue the previously listed projects already underway.

New Activities for FY 2002–2007

NIOSH occupational health studies (2003–2007), Nuclear Naval Shipyard Workers (NNSW). The proposed study will seek to evaluate the relationship between external ionizing radiation exposures and long-term health effects, including lung cancer. This workforce is regarded as having relatively minimal exposure to internal depositions of radionuclides. Measures are required to address potential confounding exposures in the shipyards which could influence the health outcomes of interest. The study will require substantial resources and will not be initiated unless significant additional resources, including personnel, are allocated for this research effort. Access to the study shipyards and data resources will also need to be established

Agency for Toxic Substances and Disease Registry Multi-Site Activities

Toxicological Profiles

Toxicological profiles are publicly and scientifically reviewed documents published by the Agency for Toxic Substances and Disease Registry (ATSDR). They summarize available knowledge about a chemical or substance and the human health consequences of exposure. Toxicological profiles identify the full range of health effects, by duration and route of exposure, observed in humans and animals from exposure to particular substances. They contain relevant information on chemical, physical, and radiological properties; production, import, export, use, and disposal; pathways migration; potential for human exposure; analytical methods; regulations and advisories; and toxicological data gaps for which additional research is needed. Health guidance values are derived, where appropriate, for route and duration-specific exposure concentrations that are expected to be without significant human risk. Profile recipients include the private sector, other government agencies, the international community, academia, citizens, and environmental groups. The profiles are an authoritative source of up-to-date information on the health effects of hazardous waste components, a guide for health assessors working at hazardous waste sites, and a tool to educate the public about the potential for health effects. Federal agencies, such as the Department of Energy (DOE), can use the profiles to make better informed decisions at their sites.

Available and Planned Toxicological Profiles

Toxicological profiles for substances that have radioactive isotopes are available for radium, radon, thorium, plutonium, and uranium. If funding is provided, ATSDR plans to prepare toxicological profiles for the substances and their radioactive isotopes listed in the following table (in order of priority).

Table 1. FY 2002–2007 Plan for Developing Toxicological Profiles

Toxicological Profiles	FY					
	2002	2003	2004	2005	2006	2007
• Americium • Cesium • Strontium	final					
• Iodine • Cobalt	public comment	final				
• Nitrates • Plutonium • Thorium • Vinyl Chloride	initiate	public comment	final			
• Chloroform • Nickel • Radium • Radon		initiate	public comment	final		
• Ammonia • Chlordane • Uranium • Vanadium			initiate	public comment	final	
• Noble and activation gases • Thallium • Tritium • Tungsten				initiate	public comment	final
• Antimony • Boron • Polonium • Technetium					initiate	public comment
• Iodine • Chromium • Nitrites • Zinc						initiate

Table 2. Sites With Chemicals Identified in the Toxicological Profiles

Site	Chemical													
	Am	Cs	Co	I	Gases	Ra	Rn	Sr	Tc	Th	Pu	U	V	H3
Brookhaven National Laboratory	X	X	X	X			X	X			X			X
Fernald Management Project Environmental		X				X	X	X	X	X	X	X		
Hanford Nuclear Reservation	X	X	X	X	X			X	X		X	X	X	X
Idaho National Engineering and Environmental Laboratory	X	X	X	X	X		X	X	X		X			X
Laboratory for Energy-Related Health Research		X				X		X						X
Lawrence Livermore National Laboratory	X	X	X								X			
Los Alamos National Laboratory	X	X	X					X				X		
Monticello Mill Tailings Site							X					X	X	
Mound Plant										X	X	X		X
Nevada Test Site	X	X	X	X				X			X			X
Oak Ridge Reservation	X	X	X	X				X	X		X	X		
Paducah Gaseous Diffusion Plant									X		X	X		
Pantex Plant						X	X			X	X	X		
Portsmouth Gaseous Diffusion Plant							X		X		X	X		
Portsmouth Naval Shipyard			X											
Rocky Flats	X	X									X			
Savannah River Site		X	X	X				X			X			X

Am = americium, Cs = cesium, Co = cobalt, I = iodine, Ra = radium, Rn = radon, Sr = strontium, Tc = technetium, Th = thorium, Pu = plutonium, U = uranium, V = vanadium, H3 = tritium

ATSDR Interaction Profiles

ATSDR is building upon its applied research program to address mixtures of potentially hazardous substances by developing interaction profiles. The main purpose of the interaction profiles is to evaluate mixtures that are of special interest to environmental public health, building on results reported in the scientific literature, on assessments based on the weight-of-evidence methodology, and on other health assessment tools. The interaction profiles undergo

scientific review for accuracy of presented data and validity of conclusions. They represent up-to-date views of the U.S. Public Health Service on health assessment issues for mixtures.

The mixtures selected for interaction profiles are relevant to the DOE complex, and initial selections are identified below. The interaction profiles will be widely distributed among other governmental agencies, the private sector, and academia and will help health assessors to evaluate special mixtures risks at DOE sites.

Table 3. Selected Mixture Groups and Example Locations

Mixture Groups	Examples of Relevant DOE Complex Locations
• Arsenic • Hydrazine • Jet fuels • Strontium • Trichloroethylene	Energy Technology Engineering Center (Santa Susana Field Laboratory, Rocketdyne)
• Cyanide • Fluoride • Uranium	• DOE sites for storage of bulk depleted uranium hexafluoride • Hanford Nuclear Reservation • Oak Ridge Reservation
• Cesium • Nitrates • Sulfates • Uranium • Vanadium	• Hanford Nuclear Reservation • Los Alamos National Laboratory • Monticello Mill Tailings Site
• Cesium • Cobalt • Polychlorinated biphenyls • Strontium • Trichloroethylene	• Hanford Nuclear Reservation • Idaho National Engineering and Environmental Laboratory • Lawrence Livermore National Laboratory • Savannah River Site
• Arsenic • Cesium • Chromium • Cobalt	• Hanford Nuclear Reservation • Lawrence Livermore National Laboratory • Savannah River Site
• Cadmium • Cesium • Cobalt • Lead • Strontium	Savannah River Site

ATSDR Mixtures Research

ATSDR proposes a two-step project to determine how simultaneous exposure to multiple hazardous substances affects toxicity. In the first step, appropriate mixtures will be identified, and in the second step, the toxicity of these mixtures will be assessed in combination. Data from DOE sites will be reviewed to identify candidate radioactive and non-radioactive substances to which individuals might be co-exposed and which could impact common target organs (i.e., the kidneys or liver). Relevant literature searches will be conducted to compile information on combined toxicity of the substances in mixtures. Based on these findings, scientific assessments will be designed and conducted to answer specific questions concerning the effects of exposures to mixtures of chemicals and the role radiation might play in increasing or decreasing adverse effects of the chemical mixtures on the overall health of human populations exposed near DOE sites.

Phase I of the project will identify pertinent mixtures found at DOE sites through contracts, grants, and staff activities. Preliminary data analyses have already identified several 3- and 4-component mixtures likely to be present at DOE sites. A more comprehensive list will be developed and assessed to identify those mixtures found in completed exposure pathways, (i.e., those to which the public is or has been exposed). Literature reviews will be conducted and findings summarized in interaction profiles to document interactions between the components of such mixtures that can impact the health of exposed human populations. Hypotheses will then be generated regarding interactions between mixtures of certain key chemicals and radioactive materials.

Phase II will subject the above-generated hypotheses to scientific testing and assessment, and extend current work efforts to mixed exposures from radioactive and chemical mixtures. Relevant multi-radionuclide and multi-chemical mixtures will be researched separately to identify the respective radiological and chemical health impacts, and jointly assessed for evidence and type of interaction. Results will be used to refine the hypotheses for general applicability.

National Iodine-131 Education Effort

This effort includes developing *Case Studies in Environmental Medicine: Iodine-131 Toxicity*, distributing the document, and educating the public and healthcare providers about iodine-131. During FY 2000, ATSDR's national partners began developing the case studies and a distribution plan. After finalizing the case studies, ATSDR will work with the agencies and community members to distribute the case studies, and to conduct health education programs for groups such as healthcare providers, community members, and other health officials based on the information in the case studies.

ATSDR Public Health Assessments and Consultations at Other Sites

ATSDR will continue to gather information to develop public health assessments at all DOE sites on the National Priorities List (NPL) and for sites for which petitions for public health assessments have been accepted. If additional DOE sites are proposed for listing on the NPL or petitions are submitted, ATSDR will rank the sites and prepare public health assessments as mandated by the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended (42 U.S.C. §9604[I]).

Because of insufficient resources to address all sites in one fiscal year, a strategy was developed to determine the order in which public health assessments would be initiated. An ATSDR site-ranking scheme was developed that evaluates and categorizes sites according to their potential to affect public health. This ranking scheme was published in the *Federal Register* (57 FR 37382).

The ranking scheme evaluates the following factors that may influence the public health implications of a site: (1) hazardous substances present, (2) population potentially affected, (3) potential for exposure, and (4) health outcome data and community health concerns.

In addition to public health assessments, ATSDR may initiate new health consultations based on identified public health concerns or at the request of DOE, the Environmental Protection Agency (EPA), or the affected communities. Priority factors for health consultations include current exposure, current health effects, impact of recommendations, data availability, time required to prepare consultation, external resource availability, and competing projects (i.e., what other projects will be delayed to initiate the health consultation).

ATSDR Health Education and Promotion Assistance with Public Health Assessments at Other Sites

ATSDR will determine its health education and promotion activities based on the findings and recommendations from the draft public health assessments and from the comments received from community residents during the public comment release period. These activities could include holding a public availability session for residents potentially impacted by the site and developing community health educational materials such as fact sheets, educational brochures, and document summaries.

Primary care providers will receive information and resources to diagnose, treat, and counsel persons concerned about the health impact of the site. These educational materials can be provided at local Grand Rounds or made available through local professional organizations.

ATSDR Health Study Activities at Other Sites

Future health studies are contingent upon the outcome of current work the agencies are conducting (i.e., the public health assessment and health studies).

Centers for Disease Control and Prevention's National Center for Environmental Health Multi-Site Activities

Centers for Disease Control and Prevention's National Center for Environmental Health Education and Training Cooperative Agreements

The Center for Disease Control (CDC's) and Prevention's National Center for Environmental Health (NCEH) will support a competitive program for health education efforts in communities near DOE nuclear weapons facilities sites.

NCEH Grants for Radiation Research

NCEH will support a competitive program of grants to (1) assess priority radiation research issues identified by CDC staff, (2) encourage professionals from a wide spectrum of disciplines to undertake radiation research programs, and (3) evaluate current and new scientific methodologies and strategies in radiation research.

NCEH Logistics Meeting Support Contract

This contract funds the conduct of federal advisory committee meetings as well as other scientific or public meetings in support of radiation research activities as required.

NCEH Communications Support Contract

This contract will help support health communications activities associated with reporting and interpreting the findings of energy-related research conducted under the Memorandum of Understanding.

National Academy of Sciences Peer Review

The National Academy of Sciences Committee on CDC Radiation Research peer reviews many reports generated as a result of research conducted by NCEH at DOE sites.

Multi-Site, Web-Based, Iodine-131 Dose Calculator

NCEH is developing an Internet tool to allow people to estimate the doses they may have received from historic releases of iodine-131 (I-131) from the Hanford Nuclear Reservation and then add those doses to ones estimated by the National Cancer Institute for I-131 in fallout from nuclear weapons testing at the Nevada Test Site. The Oak Ridge Reservation, the Idaho National Engineering and Environmental Laboratory, and the Savannah River Site have also

historically released I-131 into the environment. NCEH is considering developing an Internet tool to allow people to estimate their total historic I-131 doses from all or part of these sites, as appropriate. Summing up doses for radionuclides other than I-131 and for sites not listed above also may be considered if deemed appropriate.

Community-Based Organization Education/Training Grants

Competitive grant program gives small community-based organizations the opportunity to improve their ability to educate their local communities about energy-related health activities at DOE sites.

Centers for Disease Control and Prevention's National Institute for Occupational Safety and Health Multi-Site Studies

Comprehensive Nuclear Worker Roster and Exposure Data Base Development

HERB Epidemiological Data System (HEDS). This project will create one uniform, centralized, and secure data management system to maintain NIOSH study data used in epidemiologic research across multiple DOE sites. This database will allow the work history and exposure information for workers employed at more than one DOE site to be combined. To the extent allowed by law, information in the database will also be used to assist the Centers for Disease Control and Prevention's (CDC's) and National Institute for Occupational Safety and Health (NIOSH) in carrying out its responsibilities under the Energy Employees Occupational Illness Compensation Program Act.

Current Multi-Site Studies

➢ Multi-Site Leukemia Case-Control Study (LCCS)

➢ Cohort Mortality Study of DOE Chemical Laboratory Workers (CLWS)

➢ International Collaborative Study of Nuclear Industry Workers (IARC)

➢ Multi-site Case-control Study of Lung Cancer and External Ionizing Radiation (LUNG)

➢ Chronic Beryllium Disease Studies (BER1)

➢ Beryllium Disease Natural History (BER2)

➢ NIOSH Occupational Radiation and Energy-Related Grants (GRNT)

Sites to be Selected Following Further Review

NIOSH is proposing a number of multi-site studies for FY 2003–2007 for which specific sites have not yet been selected. Pending initial investigations and feasibility studies, these include:

➢ **NIOSH Occupational Health Study (2003–2004) Cohort Study of Neutron Exposed Workers (NUTR).** Historical neutron monitoring practices and exposure documentation would be evaluated for selected sites. The feasibility of conducting an epidemiologic investigation of the association and dose-response relationship between neutron exposures

and cancer would also be determined before launching a formal cohort study.

➢ **NIOSH Occupational Health Study (2003–2005) Combined Plutonium Workers Study (CPWS).** Contingent upon the findings of NIOSH funded studies coming to completion that have cohort members with plutonium exposures, along with evaluation of foreign studies involving plutonium exposed workers, a feasibility effort for evaluating the health outcomes of a combined group of plutonium exposed U.S. workers may be appropriate.

➢ **NIOSH Occupational Health Study (2005–2006)**

- Combined Uranium Workers Study (CUWS).

➢ **NIOSH Occupational Health Studies (2005–2007)**

- Worker Surveillance Data Analysis (SURA)
- Reproductive Biomonitoring Study (RADT)

➢ **NIOSH Occupational Health Studies (2006)**

- Clean-Up Workers: Phase 2 (HAW2)
- Breast Cancer Incidence Study (BCIS)
- Exposure Assessment of Female Nuclear Workers (EAFN)

➢ **NIOSH Occupational Health Studies (2007)**

- Combined National Laboratory Worker Study (CNLS)
- Construction Workers Cohort (CONS)
- Brain Cancer Case Control Study (BRAN)

Department of Energy Health-Related Activities

The Department of Energy (DOE) has several activities that are not covered under the memorandum of understanding (MOU) with the Department of Health and Human Services. Those activities that are funded through environmental health and involve workers at more than one DOE site include

- Epidemiologic Surveillance of Current Workers,
- Former Beryllium Workers Medical Surveillance Program,
- Former Workers Medical Surveillance Program,
- Radiation Emergency Assistance Center/Training Site Program,
- U.S. Transuranium and Uranium Registries, and
- Workers Health Surveillance.

Epidemiologic Surveillance of Current Workers

DOE has the legislative authority to monitor the impact of its operations on the health of its workforce. Epidemiologic surveillance monitors the health of current workers at participating DOE sites and evaluates the potential health impact of DOE operations on them. This monitoring enhances our understanding of the health of workers, and provides a mechanism by which worker health concerns can be addressed in collaboration with the affected workers, occupational medicine, and site management. Epidemiologic surveillance supports the DOE's only multi-site health information database linked to current workers. The program leverages existing health and safety data sources to maximize the use of current data, while limiting the fiscal burden related to data collection.

Epidemiologic surveillance assesses the overall health of the *current* DOE workforce at 14 DOE sites and facilities. The goal is to identify groups of workers that may be at increased risk for occupation-related injury and illness. In response to indications of excess risk, program staff can assess the need for additional investigations. Surveillance is based on continuous collection, analysis, and interpretation of selected morbidity, demographic, and occupational exposure data. The program is a corporate resource providing our customers with timely health information. We also provide epidemiologic and public health expertise in the evaluation of worker health concerns. Reports summarizing the results of epidemiologic surveillance are published annually and are available online. Implementation of epidemiologic surveillance has advanced the automation of health data management systems and fostered the development of state-of-the-art medical information management.

The surveillance program has generated reports on the following sites:

- Brookhaven National Laboratory
- Fernald Environmental Management Project
- Hanford Nuclear Reservation
- Idaho National Engineering and Environmental Laboratory
- Oak Ridge Reservation (Y-12 Weapons Plant)
- Pantex Plant
- Rocky Flats Plant
- Sandia National Laboratory-Albuquerque
- Savannah River Site

The surveillance program is in the process of generating reports on the following sites:

- Kansas City Plant
- Lawrence Livermore National Laboratory
- Nevada Test Site
- ORR—East Tennessee Technology Park (K-25)
- ORR—Oak Ridge National Laboratory (X-10)

Former Beryllium Workers Medical Surveillance Program

The Former Beryllium Worker Medical Surveillance Program assesses the health impacts of DOE operations on former (retired and separated) employees who have worked with beryllium. Beryllium compounds are now recognized as a serious occupational hazard, and the Office of Health Programs (OHP) is identifying and offering medical screening and diagnostic evaluations to former employees potentially at risk for chronic beryllium disease (CBD). OHP works closely with other departmental elements responsible for beryllium sensitivity screening and protection and control measures for current workers. OHP focuses on compensation for individuals who have developed CBD and research to improve the prevention, diagnosis, and treatment of CBD.

Pilot efforts were originally established in 1991 at the Rocky Flats Plant and the Oak Ridge Reservation Y-12 Weapons Plant for both current and former employees. In 1998, all DOE sites were required to establish medical surveillance programs for current employees. The projects at the Rocky Flats Plant and the Oak Ridge Reservation Y-12 Weapons Plant were, therefore, consolidated and redirected to offer medical examinations only to former employees at all DOE sites that had used beryllium.

Currently, the program is contracted to the Oak Ridge Institute for Science and Education (ORISE). ORISE offers medical screening examinations, diagnostic evaluations to individuals with positive screening results, and medical care to those who have CBD, but are not eligible for workers' compensation coverage of their medical costs. The information generated by the program is managed and analyzed to determine the prevalence of CBD; determine distribution

of CBD among former workers; generate hypotheses and stimulate research; and monitor changes and trends in disease prevalence.

Additionally, OHP supports a related effort to establish a Beryllium-Associated Worker Registry, which will help DOE understand the effectiveness of efforts to reduce exposure to beryllium. The registry will contain data on DOE contractor and federal workers, the jobs they performed while exposed to beryllium, results from screening tests for chronic beryllium disease, and the results from subsequent medical diagnostic procedures. Policy, guidelines, and directives for the registry are determined at DOE Headquarters by OHP and will be maintained by the Beryllium Registry Data Center at ORISE. The implementation date for DOE sites is January 7, 2002.

Former Workers Medical Surveillance Program

In 1996, DOE implemented the Former Workers Medical Surveillance Program (FWP) in response to Public Law 102-84, Section 3162, that directed DOE to evaluate the long-term health conditions of former workers who may be at significant risk of occupational diseases due to their former employment at DOE sites. The FWP established three goals: (1) identify groups of workers at significant risk for occupational diseases, (2) notify members of these risk groups, and (3) provide medical screening to the at-risk workers that could lead to medical interventions. DOE used a competitive solicitation process to select site-specific projects that focused on groups of at-risk workers, such as production workers and construction workers. Twelve cooperative agreements were awarded to principal investigators that are affiliated with universities, schools of public health, and labor organizations. These external teams of health experts independently evaluate DOE site hazards and exposures, and offer medical screening to former workers who may be at significant risk for occupational diseases. The teams collect and evaluate available site and worker health information, and generate new data and findings on the relationship of site-specific worker exposures to long-term health.

The projects were implemented in two phases. In phase I, a 1-year needs assessment was conducted. Based upon the results of the needs-assessment, groups of at-risk workers and site-specific exposures of concern were identified. In Phase II, members of the at-risk groups are located, notified, and offered medical screening examinations for adverse health outcomes related to occupational exposures (such as beryllium, asbestos, silica, welding fumes, lead, cadmium, chromium, and solvents). The medical screening phase can continue for up to 4 years.

Data from these projects will be summarized and made available in DOE's Comprehensive Epidemiologic Data Resource (CEDR) database for use by other health researchers. Individual project final reports and a FWP summary will be available to DOE workers, communities, and other interested parties.

The FWPs are active at the following sites:

- Amchitka Island
- Hanford Nuclear Reservation
- Idaho National Engineering and Environmental Laboratory
- Iowa Army Ammunition Plant
- Los Alamos National Laboratory
- Nevada Test Site
- Oak Ridge Reservation
- Paducah Gaseous Diffusion Plant
- Portsmouth Gaseous Diffusion Plant
- Rocky Flats Plant
- Savannah River Site

In addition, the following table lists the 12 projects that have been awarded.

Table 4. Former Workers Medical Surveillance Projects

Project Title	Recipient Project	Description
Awarded in September 1996		
Medical Surveillance for Former Gaseous Diffusion Workers at the DOE Facilities at Portsmouth, Paducah, and Oak Ridge (K-25)	Paper, Allied-Industrial, Chemical and Energy Workers International Union (PACE)	This project includes former and current hourly and salaried workers at the three gaseous diffusion plants. The current workers at Paducah and Portsmouth are now employed by the United States Enrichment Corporation.
Medical Surveillance for Former DOE Workers at the Nevada Test Site (NTS)	Boston University	This project focuses on former NTS workers who dug, maintained, and re-entered the tunnels and shafts used for underground nuclear testing. These workers could have been exposed to chemicals, radiation, and physical hazards in the underground work environment, particularly during re-entry of tunnels after nuclear tests.
Medical Surveillance for Former DOE Workers at the Rocky Flats Plant	University of Colorado Health Sciences Center	This project focuses on former workers who worked at Rocky Flats from 1951 until 1989. Because of ongoing DOE surveillance programs for beryllium and radiation at Rocky Flats, the project does not monitor for beryllium or radiation.
Oak Ridge Building Trades Medical Screening Program	University of Cincinnati Medical Center, Department of Environmental Health	This project focuses on former construction workers at the three Oak Ridge sites. Few records exist on former construction workers. Exposures varied widely and may have included beryllium, asbestos, silica, noise, radiation, welding fumes, mercury, cadmium, chromium, lead, and solvents.

Project Title	Recipient Project	Description
Former Hanford Worker Medical Monitoring Program	University of Washington, Occupational & Environmental Medicine Program	This project focuses on former production workers. These “in plant” workers operated the industrial complex, which produced nuclear materials, from 1943 until the late 1980s.
Hanford Building Trades Medical Screening Program	Center to Protect Workers’ Rights (CPWR)	This project includes former construction workers at the Hanford site. Few available records exist for these workers. Exposures varied and may have included beryllium, radiation, asbestos, silica, noise, welding fumes, mercury, cadmium, chromium, lead, and solvents.
Awarded Fall 1997		
Former Worker Medical Surveillance Program at Idaho National Engineering and Environmental Laboratory	Paper, Allied-Industrial, Chemical and Energy Workers International Union (PACE)	This project focuses on former hourly and salaried production workers.
Savannah River Site Former Production Workers Medical Surveillance Program	Medical University of South Carolina	This project focuses on former production workers at the site.
Augusta Building Trades Medical Screening Program	Center to Protect Workers’ Rights (CPWR)	This project focuses on former construction workers at the Savannah River Site. Few available records exist for these workers. Exposures varied and may have included beryllium, radiation, asbestos, silica, cadmium, chromium, lead, and solvents.
Medical Screening Program for Former Los Alamos National Laboratory Workers	The Johns Hopkins University School of Hygiene and Public Health	This project focuses on former workers, including scientists, technicians, and construction workers (highest priority for screening during the first year is on former beryllium workers).
Awarded Fall 1999		
Amchitka Workers’ Medical Screening Program	State of Alaska with the Alaska District Council of Laborers	This project focuses on those who worked on Amchitka Island between 1964 and 1993. Amchitka Island was the site of three underground nuclear tests between 1965 and 1971. Later, the Navy built and operated a radar installation on the island. The major concern is exposure to residual radiation from the nuclear tests.

Project Title	Recipient Project	Description
Awarded in Summer 2000		
Medical Monitoring of Former Atomic Weapons Workers at the Iowa Army Ammunition Plant in Burlington, Iowa	University of Iowa College of Public Health	This project focuses on former workers at the Iowa Army Ammunition Plant. Operations included atomic weapons assembly and disassembly from 1945 through 1975. The site was shared with a large Department of Defense production facility that produced high explosives.

Radiation Emergency Assistance Center/Training Site Program

DOE develops, produces, and maintains nuclear materials and radiation generating devices as a major part of its strategic mission. Accidents can have catastrophic personal and/or area consequences, such as the 1986 Chernobyl incident. Hundreds of less publicized, but very serious radiation accidents have happened, many at DOE facilities. Given this reality, DOE must be prepared at all times to deal with radiation emergencies and their consequences.

The Radiation Emergency Assistance Center/Training Site (REAC/TS) program has been a significant part of DOE's radiation protection effort for over 30 years. This program provides state-of-the-art medical assistance, dosimetric assistance, and training to handle radiation accidents that happen in the United States. The program also provides help to other nations. Personnel experienced in clinical radiation medicine are available on a 24-hour basis to evaluate patients directly or in consultation with their physicians, and to provide clinical care management, and medical followup to survivors of serious radiation accidents (about 60 calls per year request this specialized assistance). REAC/TS personnel can treat workers or members of the public exposed to radiation or radioactive materials with appropriate conventional and developmental protocols. REAC/TS's research and registry of more than 400 past accident histories and pertinent clinical data from over 133,000 exposed individuals has allowed the group to study the course of radiation-induced pathology to suggest improvements for specialized treatment protocols. The group also conducts clinical trials and maintains a selected inventory of chelating agents under Investigational New Drug Applications (IND) as ameliorative options. Over 5,000 physicians, nurses, and emergency personnel have received REAC/TS training in the medical aspects of radiation accident preparedness and management. REAC/TS unique expertise in radiation medicine is sought frequently by program offices at DOE and in other federal agencies.

U.S. Transuranium and Uranium Registries

The U.S. Transuranium and Uranium Registries (USTUR) are a unique program of human tissue research. The registries are a major component of DOE's long-standing programs to ensure that radiological protection standards and workplace control measures for occupational exposures to plutonium, uranium, and other long-lived, radioactive materials are protective of worker health.

Based on voluntary enrollment of occupationally exposed individuals, the USTUR program has become a unique resource of data, radio analytical capabilities, and research materials. The registries include the operation of two catalogued repositories (the National Human Radiobiology Tissue Repository and the National Radiobiology Archive of Tissues from animal studies). This allows researchers to use donated tissues and histopathology slides. Analysis of the distribution of radioactive elements in the tissues donated posthumously by volunteers provides critical information about the quantity of radioactive material deposited in each tissue and organ, the length of time that it remained there, and the radiation doses received by organs and systems. These data and materials help verify and refine the world's radiation protection standards and make the USTUR a major resource for understanding plutonium health effects. For example, during the past 30 years, 370 volunteers have donated autopsy samples that were analyzed for isotopes of uranium, plutonium, thorium, and americium. This resulted in thousands of analytical measurements, which formed the basis for more than 150 peer-reviewed articles and reports.

Worker Health Surveillance

The primary emphasis of worker health surveillance is to identify workers whose health may have been adversely affected by their work at DOE facilities and the provision of timely health information to those workers. Voluntary screening programs conduct either broad assessments of the health of former workers or focus on identifying workers at risk for specific health effects, such as berylliosis. These programs offer medical tests and evaluations selected to provide valuable health information directly to former workers concerned with the potential health impact of their work. Other health surveillance programs monitor the health of current workers and assist DOE sites in investigating worker health concerns. Ongoing analysis of health data from 70,000 current workers is used to identify trends in illness and injury and to give workers, management, and other stakeholders information on the health of the current workers. Worker surveillance programs includes a complex-wide Beryllium Registry and Screening Program, the Rocky Flats Former Radiation Workers' Program, a number of former workers medical screening programs, and the Epidemiologic Surveillance Program.

Appendix A
Abbreviations, Acronyms, and Symbols

AEC	Atomic Energy Commission
AOEC	Association of Occupational and Environmental Clinics
ATSDR	Agency for Toxic Substances and Disease Registry
BCIS	NIOSH breast cancer incidence study
BER1	Chronic beryllium disease study
BER2	Beryllium disease natural history
BNL	Brookhaven National Laboratory
BRAN	NIOSH brain cancer case control study
CBD	Chronic beryllium disease
CBDMP	California Birth Defects Monitoring Program
CDC	Centers for Disease Control and Prevention
CDHS	California Department of Health Services
CEDR	DOE's Comprehensive Epidemiologic Data Resource database
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CLWS	NIOSH cohort mortality study of DOE chemical laboratory workers
COHS	NIOSH Comprehensive Occupational Safety and Health Surveillance system
CNLS	NIOSH Combined National Laboratory Worker Study
CNS	Central nervous system
CPWR	Center to Protect Workers' Rights
CPWS	NIOSH Combined Plutonium Workers Study

CT	Computerized tomography
CUWS	NIOSH Combined Uranium Workers Study
DOE	U.S. Department of Energy
DRH	Mississippi State Department of Health Division of Radiological Health
DTSC	California Department of Toxic Substances Control
EAFN	NIOSH Exposure Assessment for Female Nuclear Workers
EEOICPA	Energy Employees Occupational Illness Compensation Program
EH	DOE's Office of Environment, Safety, and Health
EHI	Environmental health intervention
EMSL	EPA's Environmental Monitoring Systems Laboratory, Las Vegas
EPA	U.S. Environmental Protection Agency
ERG	Eastern Research Group, Inc.
ESRD	End-stage renal disease
ETEC	Energy Technology Engineering Center
ETTP	East Tennessee Technology Park (formerly K-25 site of Oak Ridge Reservation)
FEMP	Fernald Environmental Management Project
FMMP	Fernald Medical Monitoring Program
FMPC	Feed Materials Production Center
FNUP	NIOSH mortality/exposure assessment study at Fernald
FUSRAP	Formerly Utilized Sites Remedial Action Program
FWP	DOE's Former Workers Medical Surveillance program
GRNT	NIOSH occupational radiation and energy-related grants
HANF	NIOSH study of ionizing radiation and mortality among Hanford workers

HAW2	NIOSH cleanup workers: phase 2
HAWW	NIOSH exposure assessment of hazardous waste, decontamination and decommissioning, cleanup workers
HCHP	Hanford Community Health Project
HEDR	Hanford Environmental Dose Reconstruction
HEDS	HERB epidemiological data system
HES	Health Effects Subcommittee
HHES	Hanford Health Effects Subcommittee
HHIN	Hanford Health Information Network
HHS	U.S. Department of Health and Human Services
HSDN	NIOSH hazard surveillance in the defense nuclear industry
HTDS	Hanford Thyroid Disease Study
HTST	NIOSH multi-site study of heat stress among carpenters
I-131	Iodine-131
IARC	International collaborative study of nuclear industry workers
ICHHP	Inter-tribal Council on Hanford Health Projects
IDA	Individual dose assessment
IDH	Idaho Division of Health
IND	Investigational New Drug Application
INEEL	Idaho National Engineering and Environmental Laboratory
INEL	NIOSH cohort mortality study of Idaho National Engineering and Environmental Laboratory workers
JAMA	Journal of the American Medical Association

K-25	East Tennessee Technology Park at Oak Ridge, Tennessee (previously site of gaseous diffusion plant and other activities of the Oak Ridge Reservation)
K-25C	NIOSH K-25 cohort mortality update study
K-25K	NIOSH multiple myeloma case-control study at ORR's K-25 facility
LANL	Los Alamos National Laboratory
La-14	Lanthanum 140
LCCS	NIOSH multi-site leukemia case-control study
LEHR	Laboratory for Energy-Related Health Research
LFPW	NIOSH study on lung fibrosis in plutonium workers
LLNL	Lawrence Livermore National Laboratory
LUNG	NIOSH multi-state case-control study of lung cancer and external ionizing radiation
MAFN	NIOSH study of mortality among female nuclear workers
MALN	NIOSH Mallinckrodt cohort study
MCMS	NIOSH Mound Cohort Mortality study
MED	Manhattan Engineer District
mg/kg	Milligrams per kilogram
µg/L	Microgram per liter
MOU	Memorandum of Understanding
MSP	Middlesex Sampling Plant
NAREL	EPA's National Air and Radiation Environmental Laboratory
NCEH	CDC's National Center for Environmental Health
NCI	National Cancer Institute
NCMS	NIOSH Nevada Test Site mortality study

NF1	Neurofibromatosis, type 1
NIOSH	CDC's National Institute for Occupational Safety and Health
NMED	New Mexico Environment Department
NNSW	NIOSH study of nuclear naval shipyard workers
NPL	National Priorities List
NTS	Nevada Test Site
NUTR	NIOSH cohort study of Neutron Exposed Workers
NYSDH	New York State Department of Health
OHP	Office of Health Programs
ORISE	Oak Ridge Institute for Science and Education
ORR	Oak Ridge Reservation
PACE	Paper, Allied-Industrial, Chemical and Energy Workers International Union
PAD1	NIOSH Paducah worker study
PAMU	NIOSH Pantex worker mortality cohort study
PCBs	Polychlorinated biphenyls
pCi/L	Picocuries per liter
PGDP	Paducah Gaseous Diffusion Plant
PFRS	NIOSH radon and cigarette smoking exposure assessment in Fernald workers
PK1P	NOISH mortality patterns among uranium enrichment workers at the Portsmouth Gaseous Diffusion Plant study
PNS	Portsmouth Naval Shipyard
PNSP	NIOSH mortality update study of Portsmouth Naval Shipyard workers
PORT	NIOSH cohort mortality study of the Portsmouth Diffusion Plant
ppb	Parts per billion

PTXP	NIOSH Pantex cohort mortality study
RADT	NIOSH reproductive biomonitoring study
RaLa	Radioactive lanthanum
REAC/TS	DOE Radiation Emergency Assistance Center/Training Site
RKFL	NIOSH epidemiological evaluation of cancer and occupational exposure at Rocky Flats
SEE	Sentinel exposure event
SMR	Standard mortality ratios
Sr-90	Strontium-90
SEES	Sentinel exposure event surveillance/evaluation at DOE sites
SEER	National Cancer Institute's Surveillance, Epidemiology, and End Results program
SRS	Savannah River Site
SRSU	Savannah River Site cohort update
SSFL	Santa Susana Field Laboratory
STDN	NIOSH study of prevention of stress and health consequences of downsizing
SURA	NIOSH worker surveillance data analysis
TA	Technical Area
TCE	Trichloroethylene
Tc-99	Technetium-99
TDH	Texas Department of Health
TSCA	Toxic Substances Control Act
UCD	University of California at Davis
UCLA	University of California at Los Angeles

U-235	Uranium-235
USEC	United States Enrichment Corporation
USTUR	U.S. Transuranium and Uranium Registry
VOCs	Volatile organic compounds
WESS	NIOSH Worker Exposure Surveillance System
WHEP	Exposure History for the Construction Trades
X-10	Oak Ridge National Laboratory
Y-12	Oak Ridge Reservation weapons plant

Appendix B
Glossary of Terms

Cancer	A group of diseases which can occur when cells in the body become abnormal and grow, or multiply out of control. A malignant growth capable of invading surrounding tissues or spreading to other parts of the body.
Cohort	Population of individuals who share a common characteristic such as employment at a particular factory
Confounders	Risk factors that are associated with both disease and exposure in the source population
Decontamination	The removal of hazardous material (typically radioactive or chemical material) from facilities, soils, or equipment by washing, chemical action, mechanical cleaning, or other techniques
Decommissioning	The closing of a facility, followed by decontamination, entombment, dismantlement, or conversion to another use
Deactivation	The placement of a formerly active processing facility in a safe and stable condition until it can be decommissioned or dismantled
Dismantlement	The disassembly or demolition and removal of any structure, system, or component during decommissioning and the satisfactory interim or long-term disposal of the residue from all, or portions of, the facility
Environmental restoration	As defined in *Environmental Management: Process & Plans of the Environmental Management Program*, November, 1996; DOE/EM-0317: Cleanup and restoration of sites contaminated with hazardous substances during past production or disposal activities. Environmental restoration encompasses a wide range of cleanup activities such as stabilizing contaminated soil; pumping and testing groundwater; decommissioning process buildings, nuclear reactors, chemical separation plants, and many other facilities; and exhuming sludge and buried drums of waste.
External radiation	Radiation which is given off by a nuclear or X-ray source outside the body
Genitourinary	Pertaining to the genital and urinary organs

(Adverse) Health Effect	Injury or illness that may be the result of exposure to biological, physical, or chemical (such as germs, radiation or chemicals). May include diseases such as, cancers, birth defects, genetic effects, and death.
Healthy worker effect	Occurs when fewer deaths are observed for workers in an epidemiologic study upon comparison with the U.S. population; usually due to the selection of healthy employees from the population and the exclusion of the severely ill and chronically disabled from employment
Internal Radiation	Radiation is given off by radioactive materials that have been taken into the body
Leiomyoscarcoma	Cancerous tumor most commonly occurring in the stomach, esophagus, or small intestine.
Leukemia	A family of blood cell cancers. The diseases affect different types of white blood cells, making them abnormal in shape or number. Some, but not all, kinds of leukemia may result from exposure to chemicals or radiation.
Multiple myeloma	A rare disease that is characterized by anemia, bleeding, recurrent infections, and weakness. It is usually regarded as a form of cancer that originates in the bone marrow and involves mainly the bones. It usually occurs more frequently in men than women.
Rhabdomyo-sarcoma	Cancerous growth most commonly occurring in the head or neck but which can also be found in the sex organs, urinary tract, legs, arms, body wall, and abdomen
Volatile Organic Compounds (VOCs)	Substances which easily become vapors or gases and which contain carbon and different proportions of other elements such as hydrogen, oxygen, fluorine, chlorine, bromine, sulfur, or nitrogen. VOCs are commonly used as solvents (paint thinners, lacquer thinners, degreasers, and dry-cleaning fluids).

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